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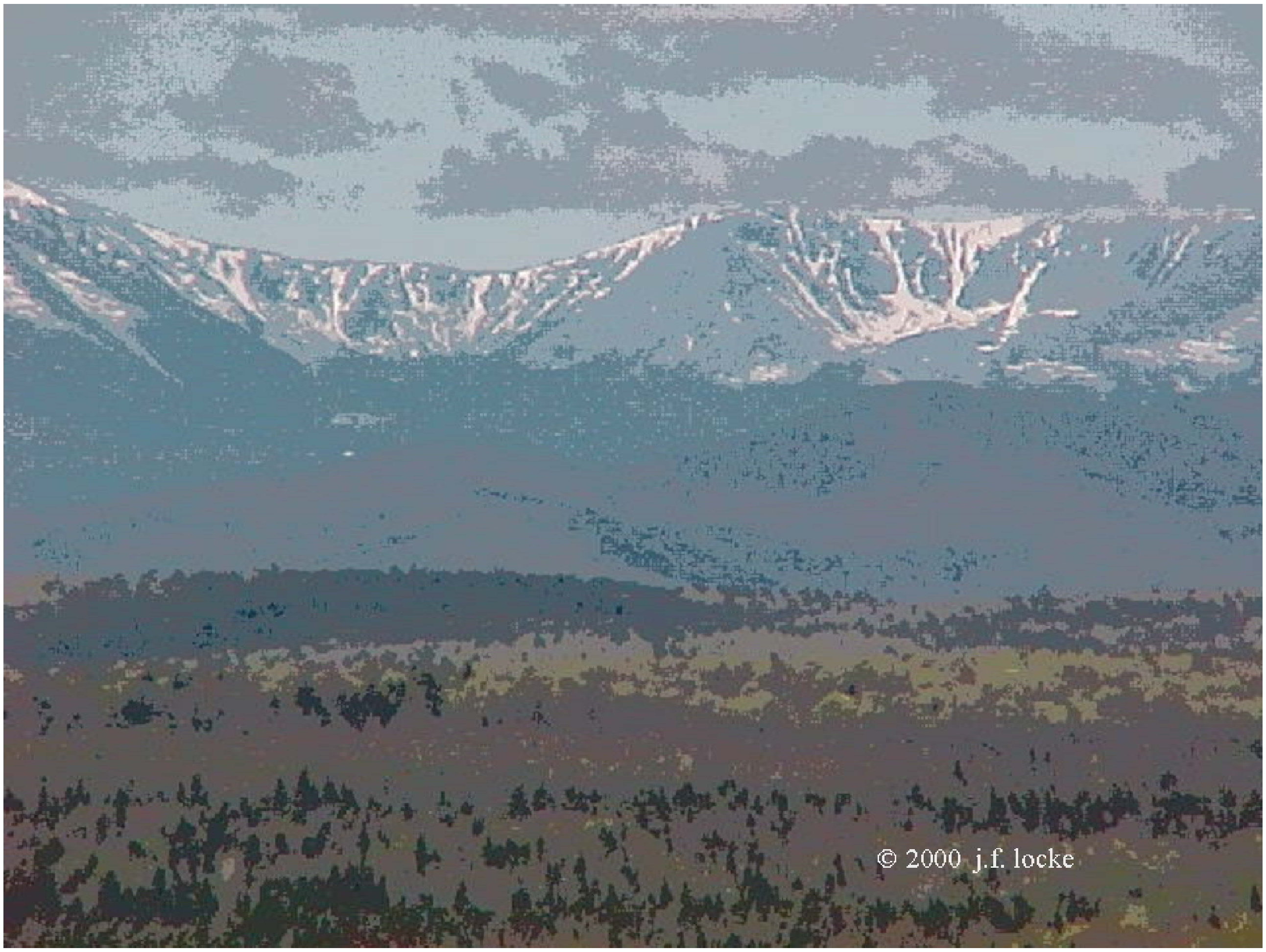

STATE OF MAINE
1999 PERIODIC
AIR EMISSIONS INVENTORY

VOLUME 1
INVENTORY DOCUMENTATION

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Maine Department of Environmental Protection
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DRAFT

State of Maine 1999 Periodic Air Emissions Inventory

Department of Environmental Protection Bureau of Air Quality

Volume I Inventory Documentation

1.0. INTRODUCTION

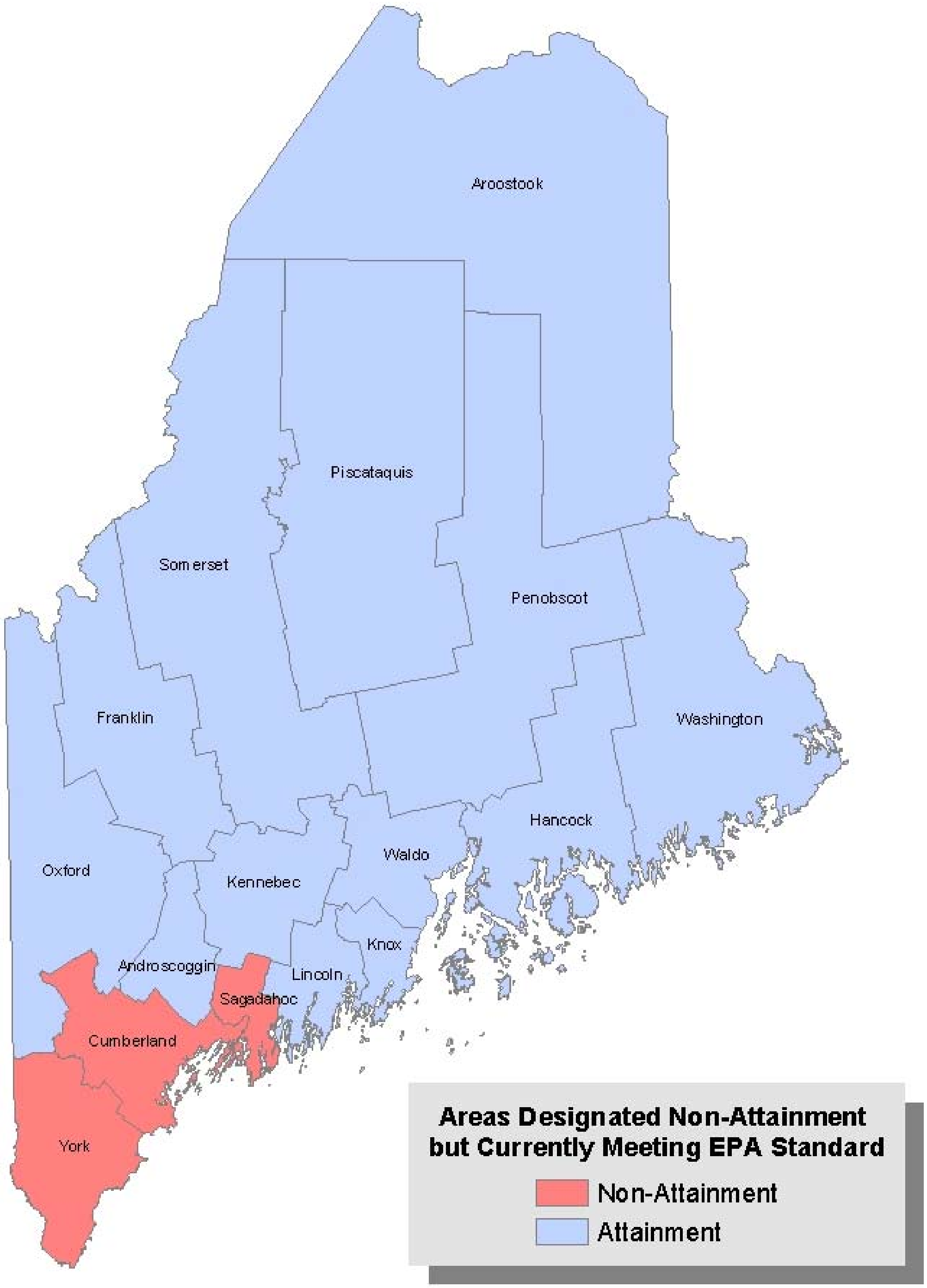
1.1. GEOGRAPHIC AREAS AND CLASSIFICATIONS

Currently, the state of Maine has only one (1) ozone non-attainment area for 1999 (see Figure 1); it is referred to as Planning Area One. Planning Area 1 includes York, Cumberland, and Sagadahoc counties, and is classified as a moderate ozone non-attainment area. Based on several years of monitoring data, indicating attainment with the ozone standard, Maine is currently requesting redesignation of Planning Area 1 to attainment. This inventory will provide, in part, data necessary for EPA to grant that request.

Androscoggin and Kennebec counties used to be classified as Planning Area 2, and Knox and Lincoln counties as Planning Area 3; both of these planning areas are also classified as moderate ozone non-attainment areas/clean data areas. Planning Area 4, consisting of Hancock and Waldo counties, was designated as a marginal non-attainment area into the early and mid-nineties, and was redesignated to attainment in 1996. Parts of the planning areas of Franklin, Oxford, and Somerset counties were classified as areas of incomplete data. Although not required, all counties have been included in this inventory.

No carbon monoxide (CO) non-attainment areas exist in Maine. Consequently, this inventory focuses primarily on ozone season emissions of precursors of ozone, i.e., volatile organic compounds (VOC), oxides of nitrogen (NOx), and carbon monoxide (CO). Statewide estimates of these criteria pollutants, where emissions occurred and where emission factors exist, have also been included in this inventory.

Figure 1. Non-Attainment Areas of Maine - 1999



1.2. BACKGROUND
The Maine Department of Environmental Protection (Maine DEP), Bureau of Air Quality Control has developed an improved emissions inventory over the past several years and has completed point source inventories for major sources for each year since the 1985 NAPAP inventory. These prior efforts served as the foundation for the 1990 Base Year Inventory, as required by the Clean Air Act Amendments of 1990, and were approved by EPA on February 28, 1997 (62 CFR, 9081).

For calendar year 1992 and subsequent calendar years, the *i-Steps^tm Infinity* software program (Section 7.0, Ref. 34), developed by Pacific Environmental Services (PES), was used to collect point-source data. In many cases, AP-42/FIRE emission factors were employed which are linked to specific source classification codes (SCC); however, some facilities used continued emissions monitoring (CEM), stack testing, local emission factors or even material balances where unique processes were described. Local emission factors were generally based on specific fuel types, pollution control equipment, and/or special operating or licensing conditions. Area source estimates were calculated using a variety of methods dependent upon the source classification category and are described further in the specific documentation for each category. Double counting was avoided by following the prescribed practices suggested by EIIP guidance, Volume III, Chapter I: *Introduction to Area Source Emission Inventory* Development (Revised Final, January 2001.)

1.3. INVENTORY STRUCTURE
Documentation consists of several parts: Section 2.0 is an overview of the entire inventory process, including the organizational structure and the flow of data; Section 3.0 details Maine DEP point source emissions inventory. This entails the identification of sources, the compilation of data, and the estimation of emissions. Section 4.0 describes the inventory of area sources. It explains how Maine D.E.P. arrived at these emissions estimates. Section 5.0 discusses emissions from on-and-off-road mobile sources, detailing documentation and data sources. Section 6.0 details Maine's estimates of biogenic emissions and discusses the required data inputs to EPA's biogenic emissions model, PC-BEIS.

2.0. OVERVIEW

2.1. ORGANIZATIONAL STRUCTURE
The 1999 Periodic Emission Inventory (PEI) was prepared by the Air Toxics & Inventory Unit of the Maine Department of Environmental Protection, the Bureau of Air Quality Control, Division of Program Planning. Personnel involved in the collection of data for the emission inventory include the following:

1 Environmental Specialist IV - Section Chief
2 Environmental Specialists III
2 Environmental Specialists II
1 Environmental Engineer

Since each of the above personnel have multiple responsibilities other than just inventory preparation, additional resources were employed in the data collection and editing process at the discretion of the

Bureau Director. Over time, these may have involved the employment of clerical or technical staff from other units & divisions, summer interns, or even in some cases, special contracted services.

2.2. DATA SOURCES

2.2.1. IDENTIFICATION OF EMISSION SOURCES

To ensure the development of a complete emission inventory, it is important to implement EPA's Emission Inventory Improvement Project (EIIP) methods and QA/QC procedures as well as identify all of the anthropogenic sources in the State of Maine. This task was completed by following EPA guidelines and by utilizing a checklist of the point and area emission sources (including mobile sources) as defined by EPA, all which may be found in Appendix A.

POINT SOURCES

The emission inventory group first determines if any sources exist in Maine for those categories defined by EPA. Reporting areas may be limited to state, county, local, regional, or even "tribal" estimates. In Maine, stationary or point emission sources were tracked using *i-Steps[tm]Infinity* v.3.3 system—a FoxPro-based computer-resident relational database software program. Previously licensed or inventoried sources, as well as newly licensed point sources were included in this inventory. Other sources of information used to determine if a source category exists in Maine were *The Maine Manufacturing Directory* and other agency databases: the State of Maine Department of Labor, Bureau of Water Quality and the Bureau of Remediation and Waste Management. Public consultant records, as well as field engineer observations and citizen complaint files were also scrutinized.

Once a new facility or emission source category was determined to be of significant size (i.e., if actual annual emissions were greater than 10 tons of VOCs, 25 tons of NOX, or greater than 100 tons of all other criteria pollutants combined), then the facility was mailed a point source (electronic) questionnaire in the form of *Satellite i-Steps* software program (the industry component of the *i-Steps Infinity* software package). In many instances this was accompanied by a set of electronic files containing company-specific historical data and in some cases was followed by a physical on-site plant inspection.

Updated emissions-data on each source was then added to the emission inventory database maintained on Maine's PC-based *i-Steps[tm]Infinity* system (at this writing, version 3.3 file/server.) The facility is also added to the compliance program and then is scheduled for systematic inspections. The data from the stationary/point source facilities went through a stringent QA/QC process. Once the inventory quality assurance tests were deemed complete and accurate, the data was then submitted to the National Emission Inventory (NEI) via EPA's central data exchange (CDX) system, using the National Inventory Format (NIF), currently version 2.0. The Emission Factor Improvement Group (EFIG) at EPA verified the data format and content and then updated the NEI. Maine's point source data was submitted the week before the deadline of June 1, 2001. Incidental corrections to the database were completed by June 25, 2001. Maine DEP sent EPA additional revisions of licensed sources in Planning Area 1 to update the 1999 NEI, Version 2.

AREA SOURCES

Additional sources for the stationary/area source emission inventory that was not included in previous inventories had to be added here as required by EPA guidelines. Any new sources were identified by comparing lists from a combination of sources, i.e., from previous point source emission inventories, questionnaires or surveys; from the yellow pages; the *Maine Manufacturing Directory;* the Maine State Departments of Labor Statistics, Motor Vehicles, and Human Services; local associations (e.g., Dry Cleaners Association); the U. S. Departments of Commerce, of Energy, and the Bureau of the Census, along with other bureaus within the Department of Environmental Protection. A variety of methods were employed to determine not only what data was to be used to compile the area source estimates but also to insure that there was no double-counting from the point source inventory. Specific area source methodologies are explained elsewhere in this document. Generally, activity data for the area source under consideration, in combination with an emission factor (usually EPA-generated), is used to calculate emissions.

MOBILE SOURCES

Mobile source emissions, as described in EPA guidelines, includes two sub-categories: highway and non-highway (or non-road) emissions. All inventories include off-road categories along with the on-road mobile sources. Mobile emission estimates were derived from data obtained from various agencies: U.S. Army Corps of Engineers, the U.S. Department of Energy, the National Weather Service, the FAA, the Maine Department of Transportation, the Maine Department of Motor Vehicles, and other DEP bureaus.

The mobile source model, MOBILE 6*,* was run using 1999 specific inputs which were then applied to 1999 VMT data obtained from the State of Maine Department of Transportation. The non-road inventory data was obtained by using the NONROAD model (June 12, 2000 version).

2.2.2. DATA COLLECTION

Maine uses a hierarchy of data collection procedures. The method of data collection is based on the three basic source categories: point, mobile, and area sources. Also considered are the levels of detail required for each category, the different types of sources being major or minor and the various methods available to employ for estimating emissions.

2.2.3. SOURCE CATEGORIES

2.2.3.1. POINT SOURCES

Data for the point source emission inventory was collected using a few different methods:

1) Electronic database files (i-Steps™ and Satellite i-Steps software diskettes),
2) On-site inspection reports from the compliance section,
3) Stack tests or CEMs data from compliance reports
4) Other Federal literature, e.g., AP-42, FIRE, etc.

The majority of the point source data was collected and verified using computer software in the form of *Satellite i-Steps*™ *Infinity* software diskettes (version 3.3.) A state-wide mailing is annually conducted to remind industries to comply with the requirements of Chapter 137—Maine's inventory reporting rule. Once the facility diskettes have been completed and returned to the Bureau of Air Quality, they are put through an extensive QA/QC process which includes a virus scan and review for completeness and accuracy. Some editing may be deemed necessary. Original submittals are retained intact and a QC copy is edited accordingly. Ideally, this review is followed by a Level II plant inspection or a "walk-through" which helps to confirm the accuracy of the data in regards to plant operations and record keeping. For each point source in Planning Area 1 the licensing engineer conducted a thorough edit/check of the data submitted. For those sources which did not participate in the electronic process (computer software reporting medium), a paper version of the emissions inventory is generated. In some rare cases, a spreadsheet or fax report from the company was used to generate the i-Steps™ electronic format. However, paper submittals are generally discouraged due to the resource issues deriving from a manual data entry process.

In cases where on-site data was not available, supplemental information for the point source inventory was obtained from EPA literature (e.g., default pollution control devices (PCD), capture and control efficiencies, or emission rates). This literature included, but was not limited to, *Compilation of Air Pollutant Emission Factors (AP-42)*, and the *Air Pollution Engineering Manual (AP-40)*, (see Section 7.0, References).

2.2.3.2. AREA SOURCES

The stationary area source inventory consists of a number of stationary emission source categories. These emissions were calculated by applying emission factors to activity-level data that was obtained from several sources discussed below. Area source inventory guidance was found in *EIIP, Volume III: Chapter1, Introduction to Area Source Inventory Development*, revised Final January 2001.

Calculation methodologies for the source categories contained in the area source inventory are generally not of uniformly high quality, compared to the point source inventory. Consequently, the level of accuracy and refinement is of lower quality in the hierarchy of data confidence.

Activity level data for the stationary area source emission inventory consists of five (5) different collection methods dependent upon the specific parameters governing each category:

1. Apportionment Techniques

Some stationary area source category emissions were developed by apportioning state or national totals to local levels. This information was realized by researching literature in the state library and by contacting various Federal and State Agencies such as the United States Departments of Energy, of Commerce, the Bureau of the Census, the Office of Policy and Management, the Department of Revenue Services, and the State of Maine Departments of Labor and of Motor Vehicles. For example, Maine DOT supplied the DEP with *vehicle miles traveled* (VMT) which was then used to apportion statewide throughput for each county in estimating gasoline distribution emissions.

2. Local Activity Level Surveys

The majority of the area source inventory was calculated using data based on actual activity levels available through state agencies or other governmental entities or by applying emission factors generated by EPA. Other techniques used for area emission estimates involved sending a statistically representative sample of questionnaires to a specific group (e.g., bakeries and asphalt manufacturers), to obtain source-specific data in order to promote the development of more accurate state activity rates thereby resulting in better emission estimates. This worked particularly well for area sources that emit a substantial amount of pollutants, especially when EPA emission rates are not geared towards Maine activities. These questionnaires were developed following EPA guidelines as stated in the Reference Section 7.0.

3. Point Source Inventory

Portions of the stationary/area source emissions inventory were also developed from the point source emissions inventory. This method was applied to smaller point sources which may have been inspected as part of the point source emission inventory, being careful not to double-count emission estimates. Surveys conducted in conjunction with the point source inventory provided independent verification of area source activity and emission level estimates.

4. Per Capita Emission Factor

Parts of the stationary area source inventory were estimated by using Maine's population data in combination with emission factors provided by EPA; for example the source categories of consumer solvent use and graphic arts facilities. Population information was obtained from the United States Department of Commerce, Bureau of the Census. At the time the population data was obtained from the web-site, year 2000 data were available for DEP to interpolate 1999 emissions, although the Bureau of the Census had not yet done so. Please see the chart below for population numbers obtained by DEP from the interpolation process.

Table 1. Population Estimates from US Census

Interpolated Population DataBase on 1990 & 2000 Census Data

Counties	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	% Diff.
Androscoggin	103793	**103940**	104086	104233	104379	104526	104673	104819	104966	105112	105259	-1.4
Aroostook	73938	**75238**	76538	77837	79137	80437	81737	83037	84336	85636	86936	-15.0
Cumberland	265612	**263364**	261117	258869	256621	254374	252126	249878	247630	245383	243135	9.2
Franklin	29467	**29421**	29375	29329	29283	29238	29192	29146	29100	29054	29008	1.6
Hancock	51791	**51307**	50822	50338	49854	49370	48885	48401	47917	47432	46948	10.3
Kennebec	117114	**116993**	116872	116751	116630	116509	116388	116267	116146	116025	115904	1.0
Knox	39618	**39287**	38956	38626	38295	37964	37633	37302	36972	36641	36310	9.1
Lincoln	33616	**33290**	32964	32638	32312	31987	31661	31335	31009	30683	30357	10.7
Oxford	54755	**54540**	54324	54109	53894	53679	53463	53248	53033	52817	52602	4.1
Penobscot	144919	**145087**	145255	145424	145592	145760	145928	146096	146265	146433	146601	-1.1
Piscataquis	17235	**17377**	17519	17660	17802	17944	18086	18228	18369	18511	18653	-7.6
Sagadahoc	35214	**35046**	34878	34710	34542	34375	34207	34039	33871	33703	33535	5.0
Somerset	50888	**50776**	50664	50552	50440	50328	50215	50103	49991	49879	49767	2.3
Waldo	36280	**35954**	35628	35301	34975	34649	34323	33997	33670	33344	33018	9.9
Wash	33441	**33628**	33814	34001	34188	34375	34561	34748	34935	35121	35308	-5.3
York	186742	**184527**	182311	180096	177880	175665	173449	171234	169018	166803	164587	13.5
Total Pop.	**1274423**	**1269774**									**1227928**	**3.8**

5. Per Employee Emission Factor
At times, it was necessary to use the employment numbers within a particular industry to develop some estimates of the stationary/area source emissions inventory. Employee information was obtained from the State of Maine Department of Labor's annual *Employment and Earnings Statistical Handbook* and from the *Standard Industrial Classification Manual*. As an additional QA/QC check, local-per-employee emission factors were developed for the surface coating source category. Further details are provided in Section 4.1.3.C.

2.2.3.3. MOBILE SOURCE EMISSION INVENTORY
The mobile source emission inventory contains two sub-categories: 1) highway and 2) non-highway or non-road emissions. The level of detail and methods used to estimate highway emissions are generally more refined than for non-highway. Previously, non-highway mobile source emissions were typically calculated using a method similar to that of area source methods, i.e., the use of activity levels along with EPA emission factors. In the 1999 PEI, DEP used EPA's NONROAD Model (June 12, 2000 version) to develop non-road emissions. This increased the NONROAD VOCs substantially compared to the previous PEI reported.

HIGHWAY

The highway portion of the emission inventory was developed using computer models to compute *vehicle miles traveled* (VMT) in conjunction with emission factors. The VMTs are calculated by MDOT through the use of the *TINIS* database using models that follow HPMS guidelines. The model inputs are collected and maintained by MDOT. The data collection procedures include traffic counts, turning studies, household surveys, and mass transit surveys. Records are also maintained and tabulated for railroad and bus ticket sales using information from the United States Department of Commerce, Bureau of Census and the State of Maine Department of Labor.

On-Road (highway) mobile source emissions were then calculated from the VMT data using emission factors derived from EPA's MOBILE 6.0 model. Input data for MOBILE 6.0 includes: age and vehicle class distribution of Maine's motor vehicle fleet, the average temperature during the ozone season, and various types of controls, such as information regarding the type of inspection/maintenance program or whether or not fuel volatility regulations were in place. The data supplied to the MOBILE 6.0 input files come from both state specific information and national default values. When state specific information is available, data is obtained from other state agencies like the Department of Motor Vehicles. National defaults are used when state specific information is not available, per EPA guidance. These default values are obtained from *The User's Guide To MOBILE 6.0* (Mobile Source Emission Factor Model) and other guidance from EPA. MOBILE 6.0 input and output files used to model on-road (refueling) emissions can be found in Appendix D of this document.

A discussion of actual VMT data generation can be found in the Maine's 1990 Base Year Air Emissions Inventory, Appendix E.

NON-HIGHWAY (2260000000)

This category includes a diverse collection of non-highway mobile source equipment ranging from Class I railroad locomotives to 2-cycle residential lawn and garden engines.

Non-road equipment emissions for 1999 were calculated using the draft EPA NONROAD model (June 2000 version). The draft version of the model currently estimates emissions for more than 80 basic types and 260 specific types of non-road equipment, based on different fuels. Fuel types include gasoline, diesel, compressed natural gas (CNG), and liquefied petroleum gas (LPG). Model input data for fuel RVP and percent sulfur were obtained from the Mobile Sources Section of the Maine DEP.

Historical temperature data for most counties was obtained from the Caribou National Weather Service on the web at: http://205.156.54.206/er/car/.

The NONROAD model does not estimate emissions from aircraft, commercial marine, or railroad locomotives. Therefore, these sources were calculated separately. Emissions from general aviation, air taxi, and military aircraft were estimated by multiplying the number of LTO (landing/take-off) cycles by composite emission factors listed in *Procedures of Emission Inventory Preparation, Volume IV: Mobile Sources*. Correction values for each aircraft type were applied to total hydrocarbon emissions to obtain an estimation of VOC emissions.

Railroad locomotive emissions were based principally upon diesel fuel-use obtained from the US Department of Energy Information Administration *Fuel Oil and Kerosene Sales* document. Given the total fuel usage by railroad locomotives in the state, statewide fuel usage was apportioned to the counties using a percentage of active track (obtained from Maine DOT) in each county. The US EPA Office of Mobile Technical Highlight *Sources Emissions Factors for Locomotives* supplied the emission factors for NOx, VOC and CO. Emissions were calculated based on formulas in Chapter 6 of *Volume IV*, assuming uniform year-round activity.

Finally, for commercial marine vessels, estimates were calculated based on the fuel sales methodology described in *Volume IV of Procedures for Emission Inventory Preparation, Mobile Sources (1989)*. Data on vessel-draft was obtained from the US Army Corps of Engineers Navigational Data Center, *1999 Waterborne Commerce of the United States Part 1, Atlantic Coast*. State-wide marine fuel usage came from the US Department of Energy Information Administration *1999 Fuel Oil & Kerosene Sales*.

2.2.4. DATA QUALITY

2.2.4.1. VALIDATION PROCEDURES

Data validation procedures include quality checks for data consistency and completeness. These quality control checks were designed into the inventory development procedures and documented in the inventory submittal. Wherever possible, these QC checks were performed electronically by computer models or programs and then manually reviewed. Regardless of the procedure, an important part of the process was to document each validation step as it took place.

This documentation is maintained by the Bureau of Air Quality. This section discusses the specific validation steps that were implemented to improve the point, stationary, and mobile source emission inventories. The implementations of these procedures were dependent upon the availability of Bureau resources. Validity checks for the point source emission inventory started with the data collection procedures and continued throughout the development of the emission inventory. Initial validation procedures utilized documented EPA validation checklists to ensure that all the pertinent emission sources were included in the emission inventory.

The next validation procedure was accomplished through the use of surveys and responses from the various industries during on-site plant inspections conducted by trained field personnel. The inspection reports were used to confirm or reconcile operational data and other inventory data-points (dates, etc.) with plant records.

REASONABILITY

Before the computerized inventory database was updated, the data was manually checked for reasonability. One of the major reasonability checks was for a field engineer or compliance inspector to compare the data with past company records. If the data did not appear to be correct or valid, it was returned to the field engineer or to the environmental specialist who conducted the inspection. Department personnel then confirmed the information with a representative from the company.

RELIABILITY AND QUALITY

Similar to the data-collection procedures, the process for evaluating the reliability and quality of the data (i.e., quality control measures) are dependent upon source categories, the desired level of detail, the types of emission sources (major or minor), and the methods used to estimate emissions. As a general rule, the quality of information provided by outside sources is only as good as its generator. Some of the procedures which were used to ensure data-quality consisted of checking dates to correspond to the inventory year, and data sources against other published data. Certain assessments were made to assure data-quality, e.g., assessing the professional capabilities and/or biases of the agencies supplying the data, understanding the purpose for which the data was originally collected, and assessing and documenting the method(s) used to compile the data.

The data quality for the point source emissions inventory is considered to be higher than other source categories because trained field personnel periodically verify facility data with on-site plant inspections. Reconciling inventory data with plant records and checking all records for reasonability is a routine part of the quality control process. In addition, license engineers scrutinize each licensed source emission inventory maintained in the State's *i-Steps* databases.

By not obtaining location-specific data to develop the stationary area source emission inventory, the quality of this inventory is lower than that of the point-source emission inventory. The basic reason for this rating is that the area-source inventory consists of numerous, scattered minor sources where it is not feasible to collect data from on-site plant inspections.

The highway source emission inventory was developed by utilizing EPA and Federal Highway Administration approved models (the *MOBILE 6.0* model and MDOT *TINIS* database, respectively). For both models, a majority of the input was based on validated data and reliable estimates. Consequently, the quality of the data is largely dependent upon the maintenance of accurate records.

For data that has a lowered level of confidence, information was confirmed by comparing annual records, tabulated figures and projected figures, and by analyzing the different data sources for consistency.

The non-highway mobile-source emission inventory was primarily developed from information obtained from outside data sources. EPA's NONROAD model that was provided to the state (June 12, 2000 version) was used to estimate these emissions.

2.2.4.2. QUALITY ASSURANCE

Staff from Pacific Environmental Services (PES, a.k.a. MacTec), an EPA contractor, visited the offices of the State of Maine, Department of Environmental Protection Bureau of Air Quality in December of 1992 for the purpose of conducting QA on Maine's 1990 Base Year Inventory data. PES reviewed the 1990 SIP emissions inventory for ozone precursors. This included reviewing the State of Maine 1990 Base Year Emission Inventories report, the *SAMS* database, State inventory forms, area source files, and summary sheets from area source calculations. The purpose of the review was to provide Quality Assurance (QA) of the base-year emissions inventory that contained stationary sources, area sources, and mobile source information. In addition to reviewing various databases, PES reviewed plant records containing activity data from the State questionnaire forms (see *Appendix F* in *State of Maine 1990 Base Year Air Emissions Inventory Volume II Appendices A-G* [1] for the PES Quality Assurance Final Report).

Subsequently, the use of *i-Steps*™ *Infinity* software program was instituted (which includes the *Satellite i-Steps*™ *Infinity* program), to serve the Air Bureau in collecting, compiling, editing, and verifying point-source emissions data supplied by the numerous facilities within Maine. Extensive quality assurance edit-check programs were run against the data after the initial data-entry or data-import processes. For calendar year 1999, most (85%) of the point source data was collected electronically with the help of point source personnel. The rest was manually entered into the criteria pollutant emissions database via *i-Steps*™ *Infinity* (file/server) software version 3.3 from paper records submitted by industry.

Extensive ongoing QA/QC edit-checks were conducted—from built-in software data-validation procedures to comparisons between actual annual emission estimates, or previous year estimates, and/or licensed allowable estimates, along with physical comparisons of plant processes and pollution control devices. On-site visits were also conducted where the specifics of a facility's data-submittal needed further scrutiny. Department engineers and inspectors also participated in the quality assurance process, especially regarding the verification of stack test data, pollution control devices (% efficiencies) or monitoring equipment (CEMs data), along with overall operational concerns and especially when local facility emission factors or estimates were utilized.

3.0. POINT SOURCES

3.1. SOURCE IDENTIFICATION

3.1.1. MAJOR SOURCES

For States within the Ozone Transport Region (as Maine is), a "major source" of air pollution is defined as a source that emits in excess of 50 tpy of VOC or 100 tpy of NOx. For emission inventory purposes, commercial or industrial sources which have the potential to emit VOCs greater than 10 tons per year, NOx greater than 25 tons per year, or a combination of the other criteria pollutants in excess of 100 tons per year are considered stationary point-sources. These sources were identified through the use of existing inventories, using actual estimated emissions from previous calendar-year databases (SAMS for 1991, and *i-Steps*™ *Infinity* databases for 1992 to date), along with permit or licensing information, inspection reports and data stored in ATS (Application Tracking System).

Since all major licensed sources are required to report to DEP and since many companies have air emission licenses anyway, merging these data-sets provided the most comprehensive listing of all major point-sources in Maine. In certain instances, the area-source inventory may have captured a facility which had otherwise eluded our existing point-source database. Whenever possible, these facilities were added to the *i-Steps*™ database and when licensed, will be added to the ATS system as well, if warranted.

3.1.2. MINOR SOURCES

Minor air pollution sources were identified in two ways. First, many small point sources were included in the list generated from a combination of the *i-Steps*™ and ATS databases. Additionally, information available in the *1999 Maine Manufacturing Directory* allowed DEP to identify firms that could be classified as point sources. Maine established that the minimum emission cut-off level, which characterizes a facility as a point source, was a VOC or NOx source with an emission potential of 10 tons or 25 tons per year, respectively. Some plants, which were estimated to be under this cutoff level, yet still emit some VOCs were included in the i-Steps™ database as minor sources.

3.1.3. OTHER POINT SOURCES

A few, more specialized point sources including publicly owned treatment works (POTW), municipal landfills, and waste transfer, storage, and disposal facilities (TSDF) have been tracked separately with regards to the periodic inventory; therefore, their emission estimates have been removed from the point source totals to avoid double counting.

3.2. ROLE OF EXISTING DATA

Data from previous years' inventories (i.e., the annual inventory) was used to classify facilities according to size. This information also provides data pertaining to each facility's operations and changes in mailing addresses, etc.

3.3. DATA COLLECTION METHODS

The DEP's principal means of data collection for the point-source inventory was the emission inventory statements developed and implemented using the *i-Steps*™ and *Satellite i-Steps*™ *Infinity* Software Programs. Major sources (as defined by their pollution potential) received a reminder in the form of a brochure/mailer, to file an annual air emissions inventory using the *Satellite i-Steps* software medium. Smaller potential sources and sources with minimal boiler emissions, but with potential VOC processes or storage emissions, may have been entered into the calendar year 1999 database as well. However, since the submittal of annual emissions inventories for the State of Maine is regulated by rules regarding Chapter 137 of Title 38 of the M.R.S.A. Section 5C, some minor sources may have been excluded from this inventory.

The annual air emissions inventories require sources to submit information regarding equipment types, combustion sources, and process-related data used to calculate emissions, as well as information pertaining to VOC use and storage, and fuel usage.

3.4. ESTIMATION PROCEDURES

Air pollutant emissions may be released from numerous sources within a facility. So, dependent upon the facility's size, nature, and number of processes, and the emission control equipment in place, emission estimates may be fairly simple or relatively complex. Information supplied by each point-source facility, for process throughput, fuel usage and their respective emission points for each process within the facility, is tracked by the *i-Steps*™ program and becomes part of the annual emissions database. *I-Steps*™ is able to generate emission estimates from this information; however, the computerized calculation system developed by EPA, i.e., *TANKS*, was used to calculate the VOC emissions from bulk-storage facilities and it is this number that is entered into the appropriate field within *i-Steps*™.

3.4.1. EMISSIONS CALCULATIONS

The emissions calculation procedure for major sources generally employed herein, involves method codes and emission factors which, for the most part, are automatically calculated. *i-Steps*™ makes use of AP-42/FIRE emission factors, &/or local factors (which are often based on stack test, CEMS data or material balances, all appropriate ways to estimate emissions). When using *i-Steps*™, the user may enter a non-AP-42 emission factor to initiate automatic calculations of emissions. The equation and information required by *i-Steps*™ used to initiate these automatic calculations are as follows:

Annual emissions =

$$E_a \text{ (tons per year)} = \frac{AR \times EF \times FP \times [1 - (CE/100) \times (RE/100)]}{2000}$$

Where: AR = annual fuel or process rate, based on SCC units per year
EF = emission factor, oftentimes: pounds per SCC unit
FP = fuel parameter (if applicable) i.e., % Ash or % Sulfur content
CE = control efficiency (% applicable)
RE = rule effectiveness (% applicable)

3.4.2. SEASONAL ADJUSTMENT OF THE ANNUAL EMISSIONS

The above equation must be modified to account for seasonal adjustments and emissions for a typical summer day. Most emission inventories have traditionally included annual emission estimates; hence, all procedures, emission factors, correction factors, and activity levels employed in this inventory represent annual average conditions. However, because high photochemical ozone levels are generally associated with the warmer months of the year, and because emissions from sources vary seasonally in some cases, it is of relative importance that ozone precursor emissions be determined during the warmer months, as this constitutes the ozone season for ozone inventories. Peak ozone season for most areas of the country is May through September. Calculating the seasonal adjustment factor for the ozone season is defined, for Maine's inventory, as the three-month period of June, July, and August.

Because VOC emissions are generally a direct function of source activity, seasonal changes in activity levels should be examined for the more important sources. Many point sources, particularly industrial facilities, however, will not show strong seasonal change in activity. For these sources, no seasonal adjustments are necessary. Therefore, the annual emission rate brought down to the daily level may be assumed to equal the daily emission rate for the ozone season.

In some processes VOC emissions are significantly influenced by temperature changes. One such example is breathing losses from fixed-roof storage tanks, which increases at higher temperatures. The equations in AP-42 and the *TANKS4* program account for the variations in VOC point-source emission totals due to changes in temperature and Reid vapor pressure (or true vapor pressure) for storage of organic liquids. This category generally accounts for a relatively small portion of the inventory overall; hence, the general use of summertime temperatures is not required for the SIP inventory but is strongly recommended when estimating emissions from these types of source categories. Specific EPA guidance for determining appropriate temperature estimates for VOC emissions from stationary sources (for ozone SIP emissions inventories) can be found in the guidance for determining temperature inputs for use in the MOBILE6 emission factor model (Section 7.0, Ref. 5) and EIIP guidance (Section 7.0, Ref. 9, *Volume IV: Mobile Sources, Procedures for Emission Inventory Preparation*).

While source activity and temperature are two of the most important variables in determining seasonal fluctuations in the emissions inventory, other variables may become significant in certain instances. For example, emissions from floating-roof tanks which store gasoline are affected by wind speed and gasoline type. Typically, gasoline has a lower vapor pressure in the summer, which tends to offset the increase in expected emissions, i.e., if temperature were the only variable in the calculation of the seasonal adjustment factor.

3.4.3. EMISSIONS FOR A TYPICAL OZONE SEASON DAY

Ozone-season summer day emissions for point sources are determined by a variety of methods. Point-source emission estimates, where emission factors and/or equations are temperature-dependent are adjusted for the ozone-season using an average daytime summer temperature. Emissions that are dependent on production or percent throughput (percent of activity occurring in the peak ozone season) are adjusted to reflect average operating rate during the summer quarter. Seasonal variations from those sources whose throughput or production rate are not uniform throughout the year, are requested in addition to the annual process and emissions data. Quarterly throughput data for each point-source is recorded in the *i-Steps*™ database and is used in automatic calculations, along with the days per week and hours per day of the normal operating schedule, to determine the summertime daily emissions. With this information it is possible to estimate daily emissions for a typical ozone season day from annual emissions estimates. For point-source facilities with known production rates or throughput values for each month or quarter of the year, the following equation can be used.

Point Sources

Tons per summer weekday

$$= \frac{\text{Annual Emissions in tons x Seasonal \% (reduced to a decimal)}}{\text{\# Ozone Days (maximum = 91)}}$$

Mobile and Area Sources

Please note that a calculation using the seasonal adjustment factor is only used for area and mobile sources where no ozone-season data is available.

Seasonal adjustment factor

= (% Activity or throughput in the ozone season /100) x 4

Therefore the tons per summer weekday expression for area and mobile sources would be:

$$\frac{\text{Tons of annual emissions x seasonal adjustment factor}}{\text{Days /wk x 13 wk. (ozone season max. = 91 days)}}$$

Example: If 30% of the annual throughput occurs during June through August

Then, 30 /100 = 0.30

And, 0.30 x 4 = 1.2 = Seasonal Adjustment Factor

However, for all facilities in the non-attainment counties, the ozone season field ("03 emissions") was used to calculate a typical ozone season daily number as it is based on actual operational data and seasonal percent throughput figures. Hence, all non-attainment counties and moderate areas in Maine were estimated this way and classify as tons per typical summer weekday (tpswd).

Facilities which were located in the attainment counties were calculated using tons per day (tpd) vs. tpswd, as the ozone season calculations do not apply to attainment counties. Therefore, county totals in attainment and state totals reflect TPD calculations based on the "lbs./day" field, which were then summed and converted to tons. The category descriptions on each spreadsheet indicate this subtlety.

3.5. CONTROL EFFICIENCIES

Point-source facilities are expected to report in-line air pollution control equipment, which may affect emissions. These pollution control devices typically use capture and control efficiency data (as supplied by manufacturers or by actual efficiency testing statistics) which provide adjustments to the plant's emission estimates. Total estimates then reflect the actual emissions with these controls in place.

3.6. WASTE TREATMENT EMISSIONS

As discussed in Section 3.1.3 above, waste treatment facilities are somewhat unique. Consequently, the Air Bureau addresses emissions from these sources separately from other point sources.

3.6.1. PUBLICLY OWNED TREATMENT WORKS (2630020000)

Recent research indicates that Publicly Owned Treatment Works (POTWs) may be responsible for high levels of VOC emissions into ambient air. VOCs may be stripped from influent water, laced with industrial waste, only to vaporize into the atmosphere.

3.6.1.1. ESTIMATION METHODS

The list of wastewater discharge sources in 2001 was obtained from the Maine DEP Water Bureau's web site http://www.state.me.us/dep/blwq/docstand/potws.pdf .The final list includes only municipal waste treatment plants (a.k.a. Publicly Owned Treatment Works - POTW) and privately owned sanitary treatment plants because major point sources such as Pulp and Paper mills with on-site waste treatment plants have reported VOC emissions as part of the point source criteria inventory report. Not enough is known about VOC emissions from other industries such as fish packing and processing facilities, vegetable processing facilities or blueberry processing plants. Although most POTWs are operated continuously, many of the privately owned sanitary treatment plants run seasonally. Some of these include ski resorts operating only in the winter and campgrounds operating only in the summer. Seasonal activity for these was taken into account when calculating emission estimates.

The Water Bureau's web site lists the source's licensed or maximum flow; this flow rate was used to estimate emissions from these plants and an emission factor of 8.9 lbs VOC per million gallons of wastewater (MGD) was used (EIIP Chapter II, Chapter 14). In addition, the Berwick POTW accepts a maximum of 40,000 lbs/year of methanol from Prime Tanning. Assuming 5% of this is emitted from the waste treatment plant, (as derived from the publication*, Estimating Releases and Waste Treatment Efficiencies for the Toxic Chemicals*), it was determined that the Berwick plant emits one additional ton of VOC per year.

<u>Sample Calculation</u>

Penobscot county = 27.23 MGD x 8.9 lbs. /MGD = 242.3 lbs. VOC /day
242.3 lbs. VOC /day /2000 lbs. per ton x 365 days /yr. = 44.2 tons per year
44.2 tpy x 0.25 /91 = 0.12 tpswd.

3.6.2. PACKAGE PLANTS

Package plants refer to small, usually automated, domestic waste treatment plants that do not require full-time supervision. In general, these facilities treat less than one million gallons per day (MGD). Principal sources of VOCs in wastewater are considered to be from industrial discharges. The Bureau of Water Quality Control does not make distinctions based on the size of waste treatment facilities and instead treats package plants just as they do POTWs. These facilities are therefore incorporated into the POTW section of the inventory.

3.6.3. TREATMENT STORAGE & DISPOSAL FACILITIES (TSDF - 2640000000)

Treatment storage and disposal facilities (TSDF) are sites for the treatment of hazardous wastes emanating from a variety of industrial activities. Waste from these activities may either be treated on-site or trucked off-site to be treated at a larger commercial facility.

3.6.3.1. ESTIMATION METHODS

According to EPA guidance, the SIMS model is an appropriate methodology for estimating emissions from treatment, storage, and disposal facilities (TSDFs), providing data is available. However, not enough detailed information was available to supply the requisite inputs to the model; therefore, it was decided that one of the following two alternative ways be used to calculate TSDF emissions. 1) To use the self-reported Toxics Release Inventory (TRI) database to establish VOC releases and 2) to use the data reported by other states in this region, for this emission category type, thereby deriving a population based factor.

Because Maine's TSDFs are storage and/or treatment facilities, emissions occur from both tanks and drums. Large quantity generators (LQGs), which store or transport waste via drums or tanks, estimate emissions using mathematical models relative to transfer, storage, and handling operations. These models require characterization of the waste contained in each unit. Unfortunately this is virtually impossible to ascertain with any degree of certainty, partly because of the historical nature of the data, but also because RCRA waste varies considerably--due to the proportion of hazardous constituents, and the concentration of those constituents. Further, the air emissions from RCRA facilities result from both production processes as well as waste handling processes. It appears that production releases are the larger contributor to VOC air emissions than the contributions from waste management practices.

Of the approximately 153 RCRA TSDFs and LQGs examined, VOC emissions data was obtained for only 57 of these facilities with no discernible correlation to the waste amounts handled. The VOC emissions for all TRI reporting facilities were included in the TSDF portion of Appendix D, spreadsheet TSDF.xls, section 3.6.3 of the 1990 Base Year Inventory (Section 7.0, Ref. 1); the non-reporting facilities were included on a separate spreadsheet. Of the RCRA facilities who submitted estimates of emissions via TRI, 36 of them emitted ozone-forming VOCs.

Emissions estimates were extrapolated for those facilities that did not report to TRI using a methodology suggested by the regional office staff of the U.S. EPA. An average emission factor (in tons of VOC per ton of waste handled) based on the TRI-reporting facilities was calculated and applied to the non-TRI-reporting facilities. On average, this factor was 0.7605 tons of VOC per ton of waste handled (in a range of 0.0001 to 563.9641 emission factors). TRI-reporting facilities had VOC emission estimates, which were used to reflect their total emissions.

Care was taken to avoid double counting in several instances. The *i-Steps*™ database was examined to ensure that no facility emission estimates were counted twice, i.e. as both a point and area source for the purposes of this inventory. However, certain facilities may appear in both the *i-Steps*™ database and the TSDF spreadsheets because facilities only reported combustion-related emissions (i-Steps) and often failed to report waste-related emissions. A summary spreadsheet in *the 1990 Base Year Inventory, Appendix D* (see Section 7.0, Ref. 1) shows total RCRA emissions (for *reporting* and *non-reporting* facilities); then this was subtracted from the total amount from *i-Steps*™. The means by which we previously calculated point source emissions was to sum the countywide emissions for certain source category codes (SCC) addressed by the TRI database (see list below). Then this result was subtracted from each pertinent county total for all TSDFs and LQGs, giving us the total emissions for this category. It is worth noting that certain counties had slightly negative emissions after point sources were removed (Franklin & Somerset Counties, an area of incomplete data), so these were treated as zero emissions. The following are source category codes for TSDF and LQG Processes:

30100101-30188599	Organic Chemical
30700101-30799998	Paper Industry
30800101-30800901	Rubber Industry
30901001-30988805	Metal Products
31501001-36000101	Miscellaneous
40100101-40299998	Surface Coating & Cleaning
40500101-40588805	Printing
40700401-49099999	Organic Chemical Storage

Emissions for the summer ozone season, based on *EIIP Guidance,* were calculated using seven days per week with a seasonal adjustment factor (SAF) of 1.2 for TSDF.

Table 2. TSDF Emission Rate Table for New England States

State	Population	VOC Emissions Tons / Year	Emission Rate Tons / 1000 People
Connecticut	3,287,116	506.5	0.154
Massachusetts	6,016,425	3,526.77	0.586
Rhode Island	1,003,000	3.3	0.003
Total	**10,306,541**	**4,036.57**	
Average			**0.392**
Average emission rate of 0.392 tons / 1000 people for the southern New England states.			

To obtain 1999 emissions, the following was done:

County Population x Emission Factor = 1990 Emissions
1990 Emissions x (1990 - 1999 Growth Factor) = 1999 Emissions

3.6.4. MUNICIPAL SOLID WASTE LANDFILLS (2620000000)

Municipal solid-waste-landfill estimates are comprised from various components of the industry, so several factors may be involved in the VOC calculations. And since three mechanism-releases are known to occur: volatilization, chemical reaction, and biological decomposition into other chemical species, all were taken into consideration.

3.6.4.1. ESTIMATION METHODS

Several resources were used for determining landfill estimates: LANDGEM (a.k.a., Landfill Gas Emissions Model), the *Solid Waste Generation and Disposal Capacity Report (1999)*, *the Active Landfill Report (2001)* by the Bureau of Land and Water Quality, the Emission Inventory Improvement Program's *Chapter 15 on Landfills*, and *AP-42 Chapter 2.4 – Municipal Solid Waste Landfills*.

The *Solid Waste Generation Report* provided the estimated number of viable years of a landfill, the amount of tons received and the remaining capacity for the (8) remaining municipal landfills for 1999.

The *Active Landfills Report* lists the license issue date for the landfill, the capacity, and the estimated years of landfill life remaining. It was assumed that the year the landfill was licensed was the year the landfill opened.

<u>Sample Calculation</u>
Since the units for the Landgem model is Megagrams (Mg), it was necessary to convert tons and cubic yards to Megagrams using the following conversations and calculations:

> Tons /year x 2000lbs /ton x 453.6grams /lb. x Mg. /1000000 grams = Mg./year
> Or Tons /year x 0.9072 Mg. /ton = Mg./year
> Cubic yards x 1160 lb. /cubic yard x 453.6 grams/lb. x Mg. /10^6 grams = Mg

The following is an example of VOC emissions from the Tri- Community Landfill in Fort Fairfield:

> Sample Facts: the landfill opened in 1977 and it had a licensed volume of 1,176,000 cubic yards, or 618,783 Mg. (1,176,000 cubic yards x 1160 lbs. /yd^3 x 453.6 grams /lb. x Mg. /10^6 grams = 618783 Mg)
>
> Estimated landfill life = 8 yr. (from 1999)
> Total life of the landfill = (8 yr. + 22 yr. (1977 - 1999) = 30 years)
> Yearly rate of waste acceptance = 618,783 Mg. /30 years = 20,626 Mg. /year

By entering the capacity, year opened, current year, and the acceptance rate, the model generates NMOC Mg/year values for each year. The Clean Air Act default values were used in the model as recommended by EIIP as opposed to using the AP-42 default values.

The NMOC value for 1999 for the Fort Fairfield Landfill is as follows:
5.25 Mega-gram/yr. x 1,000,000 grams/Megagram x lbs/453.6 grams x tons/2000lbs = 5.79 tons/year. This was then converted to tpswd; 5.79 tpy/4 quarters per year / 91 days per summer season = 0.0159 tpswd. Since the percent VOC of the NMOC can vary, and no data was available to estimate it, DEP assumed that all NMOC emissions were equivalent to VOC emissions. Therefore, the Fort Fairfield landfill emits approximately 0.016 tons per summer weekday.

For landfills with no licensed volume listed, the number was generated assuming the tons received in 1999 was the same for each year, which was then used to back-calculate the volume.

For example, the Bath Landfill opened in 1982, and has 10 years remaining in its operating life. Therefore, the landfill will have 27 years total life (2009-1982). In 1999 the waste acceptance rates was 24,273 tons/year. The landfill capacity would then be calculated at 27 years x 24273 tons/year = 655371 tons of landfill capacity (594552 Mg).

3.7. RULE EFFECTIVENESS

3.7.1. BASIS

Sources subject to rule effectiveness calculations used the 80% default factor per EPA guidance. (The following pages list rules for which a rule effectiveness calculation may apply.)

3.7.2. APPLICATION

The *i-Steps*™ equations are capable of adjusting estimated emissions for rule effectiveness with regards to specific regulations for certain point source types. Adjustments were made for those sources subject to VOC regulations in effect in the State of Maine, as codified in Title 38 M.R.S.A. Sections 585 and 343.

4.0. AREA SOURCES

4.1. STATIONARY AREA SOURCES -- Activity Level Data Sources/Methods & SCC

The following is a list of stationary area sources accounted for by the 1999 inventory and for which activity level data was obtained and/or estimated:

1. Gasoline Distribution
    a. Tank truck unloading into underground tanks (2501060053)
    b. Vehicle refueling (subsumed into highway mobile sources, 2501060101)
    c. Underground tank-breathing (2501060201)
    d. Tank trucks in transit (2505030120)
    e. Aircraft refueling (2275900000)
    f. Petroleum vessel loading and unloading losses (2505020000)
2. Stationary Fuel Use (2103008000 Commercial; 2104008000 Residential)
    a. Coal combustion
    b. Fuel oil combustion
    c. Kerosene combustion
    d. Natural gas and liquid petroleum gas combustion
    e. Wood burning
3. Stationary Source Solvent Usage
    a. Dry cleaning (2420000000)
    b. Surface cleaning & solvent degreasing (2415000000)
    c. Surface coating (2401000000)
    d. Graphic arts (2425000000)
    e. Asphalt paving (2461022000)
    f. Pesticide application (2461800000)
    g. Commercial/consumer solvent use (2465000000)
    h. Synthetic organic chemical storage tanks (2510995000)
    i. Barge, tank, tank truck, rail car, and drum cleaning (2461160000)
4. Bio-process Emissions Sources
    a. Bakeries (2302050000)
    b. Breweries (2302070001)
    c. Wineries (2302070005)
    d. Distilleries (2302070010)
5. Catastrophic/Accidental Releases (2830000000)
    a. Oil spills
    b. Rail car, tank truck, and industrial accidents

6. Solid Waste Incineration (2601000000)
    a. On-site incineration (2601020000)
    b. Open burning (2610020000)
7. Other Stationary Area Sources
    a. Forest fires (2810001000)
    b. Slash burning and prescribed burning (2810005000)
    c. Agricultural burning (2810500000)
    d. Structure fires (2810030000)
    e. Vehicle fires (2810050000)
    f. Orchard heaters (2801520000)
    g. Leaking underground storage tanks (2660000000)

Area source activity levels, such as production rates or fuel usage are typically used to estimate emissions for these source categories. The following methods may be used to measure area source activity levels and emissions:

1. Applying point source methods; e.g., using mail or telephone surveys,
2. Per capita emission factors,
3. Emissions-per-employee factors, or
4. Apportioning national totals to the state level.

Sometimes, when the activity levels are obtained on a statewide basis they must be dis-aggregated into county levels using population estimates or possibly some other surrogate representative of the level of human activity. This then becomes the apportionment factor.

4.1.1. GASOLINE DISTRIBUTION

Evaporative emissions occur at all stages in the gasoline distribution process. Gasoline operations, generally inventoried as area sources include dispensing outlets (i.e. gas stations) and gasoline tank trucks in transit. Dispensing outlets that emit less than 10 tons of VOC per year are considered to be area sources. But please note that bulk terminals and bulk plants, and *intermediate* distributive points between refineries and outlets were inventoried as point sources and are not included here.

VOC emissions (petroleum product vapor losses) from gasoline dispensing outlets result from the following activities: tank truck unloading into underground storage tanks, underground tank breathing, and vehicle refueling. Please note that vehicle refueling is now included with mobile source emissions, primarily because these emissions were calculated using the MOBILE 6.0 model.

Gasoline distribution losses occur in other ways too: during transit of tank trucks, the refueling of aircraft, and the loading/unloading of petroleum vessels and emissions for these subcategories of the gasoline distribution system were calculated using emission factors from AP-42 and EIIP Guidelines.

The approach used to determine VOC emissions from gasoline distribution was by using gasoline sales, apportioned to each county, according to VMT, and then by applying the individual or composite emissions factors, process by process. Additionally, these results were adjusted for rule effectiveness, where applicable. And finally, the emissions estimates were seasonally adjusted for a typical ozone day (tons per summer weekday, or tpswd). The general formula for these categories is:

$$\text{Uncontrolled Emissions (tons /day)} = \frac{\text{(gasoline sales) x (emission factor) x (seasonal adjustment factor or SAF)}}{\text{\# of activity days per year}}$$

4.1.1.1. ESTIMATION METHODS

A) Tank Truck Unloading (Stage I)

Description

VOC emissions from tank-truck-unloading were determined by the type of filling-method at each service station, along with the throughput or gallons of gasoline sold. The Department's regulations on gasoline service stations (Chapter 118), and underground storage tanks, resulted in the replacement of numerous tanks without submerged fill (i.e., with splash fill) throughout the 1990's. Therefore, only two methods for estimating emissions from tank-truck-unloading now exist: submerged and balanced-submerged (submerged with dual point or coaxial system).

Methodology

VOC emissions were calculated according to the method in EIIP (Chapter 11, Gasoline Marketing). The following emission factors were applied for estimates of VOC emissions from service stations:

1. Balanced Submerged Fill 0.3 lbs. /10^3 gallons
2. Submerged Fill 7.3 lbs. /10^3 gallons

The Maine DEP Oil and Hazardous Waste database indicates that 95% of the tanks have been replaced, and that no splash filling occurs. The Air Bureau assumed that 95% of these service station tanks are equipped for balanced submerged fill, and 5% are equipped for submerged fill.

The default of a rule effectiveness of 80% was used for the balanced submerged fill tanks. It was assumed that deliveries were for 6 days per week of the year (312 days).

Sample Calculation

Cumberland County through-put apportionment:

3,035,514,645 VMT for Cumberland County x 694,432,869 Statewide throughput gasoline divided by 14,298,810,394 State Total VMT
= 147,422,134 gallons throughput for Cumberland County.

Vapor Balanced Stations:
147,422,134 gallons through put for Cumberland County x 95%
= 140,051,027.4 gallons for Stage I.

140,051,027.4 gallons for Stage-I x (1- (0.3 lbs. /1,000 gallons) x 0.80
= 53,809.079 lbs. VOC or 26.90 Tons VOC per year.

Tpswd = 26.90 Tons VOC per year /312
= 0.09 tpswd for Vapor Balanced Stations

Submerged Fill Stations:
147,422,134 gallons through put for Cumberland County x .05 = 7,371,106.707 gallons for submerged fill.

7,371,106.707 gallons for submerged fill x (7.3 lbs. /1,000 gallons)
= 442,26.641 pounds VOC or 22.11 tons.

Tpswd = 22.11 Tons VOC per year /312 = 0.07 tpswd for Submerged Fill Stations

Total tpswd for Tank Truck Unloading:
0.09 tpswd for Vapor Balanced Stations + 0.07 tpswd for Submerged Fill Stations
= 0.16 tpswd for Tank Truck Unloading.

B) Vehicle Refueling Operations

These losses are subsumed into mobile source emission calculations done in MOBILE 6.0. Tier II, on-board canisters, and improvements in fuel will decrease the emissions of this category.

C) Underground Tank Breathing

Description

Underground tank breathing occurs when gasoline is pumped out of the tanks and into the pump lines. Pressure changes cause air to move into the tank, resulting in evaporation of gasoline into the air.

Methodology

The same gasoline sales figures used in tank truck unloading and tank trucks in transit were used for underground tank breathing. Accordingly, 1999 statewide gasoline usage was apportioned to the county based on the ratio of county 1999 VMT to state 1999 VMT. The emission factor for calculating VOC emissions from underground tank breathing and emptying operations (1.0 lb/10^3 gals through-put) was obtained from EIIP (Volume III, Chapter 11, Section 1, Table 11.3-1, Gasoline Marketing) which extracts the emission factors from AP-42 (Volume I, Table 5.2.-7). Underground tank breathing occurs continuously, so no seasonal or activity adjustment is necessary.

Sample Calculation (Cumberland County)

County throughput x emission factor = emissions
147,000 gallons x (1 lbs. VOC /1000 gallons throughput)
= 147,422.14 lbs. VOC per year or 73.71 tons per year VOC.

Converting to tons per summer weekday = 73.71 tons per year /364 days per year = 0.2 tpswd

D) Tank Trucks in Transit

Description

Evaporative losses from tank trucks in transit are caused by leaky seals and valves on petroleum delivery trucks or by temperature/pressure changes. Emissions occur during two modes of transfer:

1) trucks loaded with fuel during transport from the bulk plant/terminal to the service station, &
2) trucks returning with vapor.

Methodology

DEP used the emission factor from EIIP (Volume III, Chapter 11, Section 4.1), for loaded (0.005 lbs. VOC/1000 gallons throughput) and unloaded tank trucks (0.055 lbs. VOC/1000 gallons throughput). These two emission factors were added to obtain a composite emissions factor, per EPA guidance. The same gasoline sales figures used in tank truck unloading and underground tank breathing were used for tank trucks in transit. Accordingly, 1999 statewide gasoline usage was apportioned to the county, based on the ratio of county 1999 VMT to state 1999 VMT.

Bulk plants account for 25% of the national distribution of petroleum products, but in Maine it was estimated to be 10% or less for the distribution of gasoline. EPA guidance indicates that the presence of bulk plants requires an additional accounting for gasoline transported between bulk terminals and bulk plants. Therefore, gasoline sales need to be increased by the percentage that passes through these bulk plants, i.e. 10%. Hence for Maine, the gasoline sales figure needs to be increased by a factor of 1.1 to account for bulk plant distribution.

For the purpose of attributing emissions to counties, it is assumed that emissions occurred in the county where the gasoline deliveries took place. This assumes that delivery across county boundaries was equal. For example, the amount of gasoline transported into Cumberland County is equal to the amount exported out. This is unlikely to be true, but no information is available regarding county gasoline transport. It was also assumed that tank trucks would be in transit 6 days per week (i.e. operating 312 days per year).

Sample Calculation (Cumberland County)

County Emissions = County gallons x Bulk Plant adjustment x Combined Full & Empty Tank Trucks in Transit Emission Factors /2000 x activity days per year.

Cumberland County VMT apportionment (%):
3,035,514,645 VMT /14,298,810,394 Total Maine VMT for 1999 x 100 = 21.23%.

Tank Truck Transport Emissions for Cumberland County:
694,432,869 State total gasoline throughput x 21.23% /1,000
= 147,422 Gallons transit in Cumberland County.

Full Tank Trucks Transit:
147,422 Gallons transit x (0.005 lbs. VOC /1000 gallons throughput) = 737.11 lbs. VOC /yr.
737.11 lbs. VOC /yr. x 1.10 adjustment factor = 810.82 lbs. VOCs

Empty Tank Trucks Transit:
147,422 Gallons transit in Cumberland County x (0.055 lbs. VOC /1000 gallons throughput)
= 8,108.21 lbs. VOC /year.
8,108.21 lbs. VOC /year x 1.10 adjustment factor = 8,919.03 lbs. VOCs

Total Tank Truck in Transit:
810.82 lbs. VOC per year Full Trucks
+ 8,919.04 lbs. VOC per year Empty Trucks /2,000 lbs. /ton
= 4.86 Tons VOC per year for Cumberland County.

Conversion to tpswd:
4.86 Tons /312 days of operation = 0.0156 tpswd

E) Aircraft Refueling

Description

Emissions from aircraft refueling occur when vapor-laden air in a partially empty fuel tank is displaced into the atmosphere as the tank is refilled. Jet kerosene (i.e., jet fuel used primarily by commercial turbojet and turboprop aircraft), jet naphtha (used primarily by military aircraft), and aviation gasoline (used by general aviation aircraft with reciprocating engines) are the three most common types of aircraft fuels used in the US.

Methodology

Methods found in AP-42 were used, as instructed by EPA Region 1. Using statewide fuel sales data obtained from the Bureau of Oil and Hazardous Waste, jet fuel and aviation gasoline totals were then apportioned to each county based on the number of landing to takeoff (LTO) cycles. It should be noted that no jet naphtha sales have been reported in the state since May 1996. The Department of Defense reports a complete changeover from the gasoline-based JP-4 (jet naphtha) to the safer kerosene based JP-8 in 1996.

Emission factors for aircraft refueling are temperature dependent. For this reason both summer daily and annual emission factors were estimated using average annual and summer high temperatures for each county and the corresponding fuel true vapor pressures from Table 7.1-2 of AP-42. Historical temperature data were obtained from the Caribou National Weather Service on the web at http://205.156.54.206/er/car/.

Emission factors for aircraft refueling were then estimated for each county utilizing the loading loss equation below:

$$EF = \frac{12.46 \times S \times P \times M}{T}$$

Where:

EF = emission factor expressed in pounds VOC per 1000 gallons fuel throughput
S = saturation factor of 1.45 from Table 5.2-1 of AP-42
P = fuel true vapor pressure in PSI from Table 7.1-2 of AP-42
M = fuel molecular weight in lb./lb.-mole from Table 7.1-2 of AP-42
T = study temperature in degrees Rankine

Emissions from aircraft refueling are assumed to be uniform throughout the year. The following method was employed to determine summer daily and annual aircraft refueling losses for all counties:

$$C_{jk} = S_{jk} \times \%_{LTO}$$
$$C_{ag} = S_{ag} \times \%_{LTO}$$
$$E_T = (C_{jk} \times EF_{jk}) + (C_{ag} \times EF_{ag})$$

Where:

S_{jk} = Actual statewide fuel sales of jet kerosene (JP-1 & Jet-A)
C_{jk} = Estimated county fuel sales of jet kerosene (JP-1 & Jet-A)
S_{ag} = Actual statewide fuel sales of aviation gasoline (Avgas)
C_{ag} = Estimated county fuel sales of aviation gasoline (Avgas)
$\%_{LTO}$ = The percent of LTO cycles for county X
EF_{jk} = Jet kerosene refueling loss emission factor for VOC
EF_{ag} = Aviation gasoline refueling loss emission factor for VOC
E_T = Total VOC refueling loss for county X

Sample Calculation

Example: VOC Cumberland County

Annual
60,738,048 Gallons Jet Kerosene x 19% LTOs = 11,556,218 Gallons
(11,556,218 Gallons x 0.000036 Lbs. /Gal VOC) /2000 = 0.208 Tons VOC

1,040,970 Gallons Avgas x 19% LTOs = 198,058 Gallons
198,058 Gallons x 0.007983 Lbs. /Ton VOC = 0.791 Tons VOC

0.208 Tons + 0.791 Tons = 0.998 Tons VOC for 1999

Summer
(11,556,218 Gallons Jet Kerosene x 0.000064 Lbs /Gal VOC) /2000 x 0.25 /91 Days
= 0.002 Tpswd VOC

(198,058 Gallons Ave gas x 0.01165 Lbs. /Ton VOC) /2000 x 0.25 /91 Days
= 0.004 Tpswd VOC

0.002 Tons + 0.004 Tons = 0.006 Tpswd VOC for 1999

F) Petroleum Vessel Loading & Unloading Losses

Description

Using data from the U.S. Army Corps of Engineers publication *Waterborne Commerce of the United States* (15) pertaining to the movement of petroleum products throughout state coastal waters, estimates were made for this category source. All evaporative losses were calculated using EPA's preferred-method given in EIIP (Volume III: Chapter 12, section 4). Total petroleum product movement was obtained from the foreign "import" and "export" and the domestic "receipts" and "shipments" columns of *Waterborne Commerce of the United States.*

Methodology

Loading losses were calculated by applying emission factors from EIIP for ship/ocean vessel and barge loading, to total export, shipment, and outbound petroleum throughput. The relative percentages of barges versus tankers were extracted from "Trips and Drafts" section of the *1999 Waterborne Commerce of the United States* (see Section 7.0 Ref. 15). It should be noted that very little marine loading of petroleum takes place in Maine harbors.

Ballasting and transit losses do indeed occur. Emissions from ballasting are a function of the amount of ballast water used. According to AP-42 guidance, 15%-40% of total product transferred is replaced with ballast water. For the 1999 PEI, a 40% ballast rate was used. It should be noted that many ships are equipped with segregated ballast tanks that effectively control VOC losses during ballasting. The relative percentage of ships operating in Maine waters with segregated ballast tanks is unknown;

therefore it is assumed that all ships are *not* equipped with segregated tanks. Emission factors from EIIP were applied to the adjusted import and receipt freight totals to estimate VOC losses from marine ballasting.

As for transit emissions, the estimate is dependent on the length of time the ship was in the inventory area. Since little data exists for this category, it was assumed that the ships/barges were in port for only one day during unloading. Emissions from petroleum distribution are assumed to be uniform year-round and therefore no daily or seasonal adjustments were made.

Evaporative VOC losses (working losses) from marine vessel unloading to bulk storage tanks at terminals have been accounted for in the point source inventory.

<u>Sample Calculation</u>

Example: VOC Cumberland County

Loading Loss*:
(253,200 1000 Gallons Residual x 74% Ship x 0.00004 Lbs. VOC /1000gal) /1000
+ (253,200 Gallons Residual Oil x 26% Barge x 0.00009 Lbs. VOC /1000gal) /1000
= 0.013 Lbs. VOC
*Residual oil was the only petroleum product shipped from Cumberland ports in 1999.

Ballasting Loss:
(506,071,429 1000 gal Gasoline x 40%* x 0.8 Lbs. VOC /1000gal) /1000
+ (4,300,282,690 1000 Gal. Crude Oil x 40% x 1.1 Lbs. VOC /1000 gal) /1000
= 2,054,000 Lbs. VOC
*Assumes a 40% ballast rate

Transit Loss*:
((506,071,000 gal. Gasoline x 2.7 Lbs. VOC /1000 gal.)
+ (2,600,000 gal. Kerosene x 0.005 Lbs. VOC /1000 gal.)
+ (263,000,000 gal. Distillate x 0.005 Lbs. VOC /1000 gal.)
+ (53,200,000 gal. Residual x 0.00003 Lbs. VOC /1000 gal.)
+ (4,300,282,690 gal. Crude x 1.3 Lbs. VOC /1000 gal.) /1000) /7 Days
= 994,000 Lbs. VOC
*Assumes ship/barge in port for 1 day

Tpswd:
(0.013 Lbs. + 2,054,000 Lbs. + 994,000 Lbs.) /2000 Lbs. x 0.25 /91 Days = 4.2 tpswd

It should be noted that emissions from petroleum vessel loading, ballasting, and transit losses have increased from 1.3 to 4.2 tpswd between 1990 to 1999. This phenomenon can be attributed to a number of factors, foremost of which includes a 162% increase in the quantity of crude petroleum handled by Maine ports, and a change of the crude oil ballasting emission factor from 0.46 pounds per gallon to 1.1 pounds per gallon. With the 1990 base year inventory an assumption was also made that VOC losses from petroleum vessel loading operations were negligible. The 1999 periodic inventory includes about 8.4 tons per year of VOC losses from petroleum vessel loading operations at ports in Cumberland and Hancock counties. Finally, further assumptions were made by Maine DEP in 1990 that 25% of vessels transporting gasoline and 50% of vessels transporting crude petroleum were equipped with segregated ballast tanks. Currently, it is unclear on what basis these assumptions were made; therefore, they were not employed for 1999.

4.1.2. STATIONARY SOURCE FUEL USE & FIRES

4.1.2.1. ESTIMATION METHODS

<u>Description</u>

This category includes small boilers, furnaces, heaters, wood stoves, and other heating units too small to be inventoried as point sources. The methodology for estimating VOC emissions (as well as other pollutants) are to obtain the type and amount of fuel used in the residential, commercial/institutional, and industrial sectors.

a) Coal Combustion

Coal consumption is broadly classified into two major types, bituminous and anthracite. Two other minor types of coal are sub-bituminous and lignite. Anthracite coal is of a higher grade, has more fixed carbon and is less volatile than bituminous coal. Of the two types, Maine residents primarily use anthracite coal for heating purposes in the winter; while the commercial sector uses a mixture of anthracite and bituminous coal.

b) Fuel Oil Combustion

Fuel consumption covers two major types of oil, distillate and residual oils. Distillate oil includes #1, #2, and #4 and is used mainly in residential and commercial boilers. Residual oil (#5 and #6) is also used in commercial boilers but to a much lesser extent.

c) Kerosene Combustion

Along with fuel oil, kerosene is another significant fuel used in residences. The amount of kerosene that the commercial sector uses is similar to that of residual oil.

d) Natural Gas/LPG Combustion

The emission factor for natural gas and LPG is provided in AP-42 and listed in Table 2.

e) Wood Burning

The data for wood burning for both commercial and residential sectors are provided in the DOE report in cords per year, and the emission factor used from AP-42 is in pounds per ton. Hardwoods are burned primarily for residential and commercial use, and therefore DEP used the AP-42 assumption (Appendix A) that there are 128 cubic feet in a cord of hardwood, and that each cubic foot weighs about 36.5 pounds. A cord of wood then weighs approximately 2.336 tons. According to the State Planning Office (SPO), 15% of the wood burned as fuel is consumed in a fireplace, and of the remaining 85%, it is assumed that 33%

is burned in catalytic stoves, and 67% is burned in non-catalytic stoves. This assumption is not expected to bias the results significantly since the emission factors for the two types of stoves are not that different.

Methodology

Emissions of VOC, NOX, and CO were determined by multiplying the quantity used (fuel usage, apportioned to county by population and by fuel type, i.e., #2 fuel oil, wood, etc.), by the appropriate emission factors (AP-42). Fuel usage for each category and sector was obtained from the Department of Energy's *State Energy Report* (DOE Report) found at http://www.eia.doe.gov/emeu/sep/me/frame.html.

The values for each fuel type found in i-STEPS, was then subtracted from the fuel used by the industrial sector to account for sources not included in the i-STEPS databases. This always yielded a negative number and so it was assumed to be zero. Table 1 lists the DOE fuel usage data (by fuel type) that was burned in the both the residential and commercial/institutional sectors.

TABLE 3. 1999 Annual Stationary Fuel Use - Commercial & Residential

Fuel type	Statewide use	Fuel type	Statewide use
FUEL OIL - in 1000 Gallons		**LP GAS**- in 1000 gallons	
Residential	235,746	Commercial	5,261
Commercial Distillate	88,421	Residential	29,862
Commercial Residual	4,095		
		COAL - in tons	
NATURAL GAS - in MCF		Commercial	1,000
Commercial Distillate	3,000	Residential	2,000
Residential	1,000		
		KEROSENE - in 1000 Gallons	
WOOD - in Cords		Residential	48,479
Commercial Boilers	23,000	Commercial	4,253
Fireplaces[1]	25,050		
Catalytic Wood Stoves[2]	46,844		
Non-catalytic Stoves[3]	95,107		

In previous inventories, the annual fuel usage was adjusted by way of a seasonal adjustment factor (SAF) in order to make a determination on the ozone season fuel usage. EPA had originally recommended an SAF of 0.3 for residential sources and 0.6 for commercial/ institutional sources. However, for the 1999 PEI, a ‘heating degree day’ approach was used to more accurately reflect fuel use.

[1] 167,000 cords of residential wood burned - 15% in fireplaces
[2] 167,000 cords of residential wood burned - 33% of remaining 85% catalytic
[3] 167,000 cords of residential wood burned - 67% of remaining 85% non-catalytic

DEP obtained the average number of heating degree-days (based on the 30-year period between 1961 and 1990 for Portland, Maine) from EPA Region I. The percentage of heating degree-days during the ozone season--June through August, was 2.03%; so, this same percentage was applied to all other counties in Maine.

Table 4. AP-42 Emission Factors - Fuel Combustion

FUEL TYPE	UNITS	VOC	NOX	CO
Fuel Oil - Residual & Distillate				
Residential	Lbs./1000 gal.	7.13.E-01	1.8E+01	5E+00
Commercial Distillate	Lbs./1000 gal.	3.4.E-01	2E+01	5E+00
Commercial Residual	Lbs./1000 gal.	3.4E-01	2E+01	5E+00
Natural Gas				
Commercial Distillate	Lbs./10^6 cu. ft.	5.5E+00	1E+02	8.4E+01
Residential	Lbs./10^6 cu. ft.	5.5E+00	9.4E+01	4E+01
Wood				
Commercial Boilers	Lbs./ton	3.8.E-02	5.E-01	6.00.E-01
Fireplaces	Lbs./ton	2.29E+02	2.6E+00	2.526E+02
Catalytic Wood Stoves	Lbs./ton	1.50E+01	2E+00	1.070E+02
Non-catalytic Stoves	Lbs./ton	1.20E+01	2E+00	1.408E+02
LP Gas				
Commercial	Lbs./1000 gal.	3.E-01	2.9E+01	2.1E+00
Residential	Lbs./1000 gal.	3.E-01	1.4E+01	2.1E+00
Coal				
Commercial	Lbs./ton	7.E-02	9.E-02	2.E+01
Residential	Lbs./ton	5.E+00	9.E+00	3.E+02
Kerosene				
Residential	Lbs./1000 gal.	3.4.E-01	1.8E+01	5E+00
Commercial	Lbs./1000 gal.	7.1.E-01	2.E+01	5.E+00

Sample Calculation: County fuel use = Statewide fuel use x % population in county

Example #1: Cumberland County Residential Fuel Oil burning for VOC
263,364 (Cumberland pop.) /1,269,775 (State pop.) = 20.74%
235,746 - 1000 gallon (statewide) x 20.74% = 48,896 - 1000 gallon (for Cumberland)
48,896 - 1000 gallons x 0.713 lb. /1000 gallons x 1 ton /2000 lbs. = 17.4 tons per year

The formula for converting tons per year (tpy) to tons per summer weekday is as follows:
(Tpy x 0.3) /(7 x 52) = tpswd
Tpy = 17.4
0.3 constant EPA seasonal adjustment factor for residential fuels
7 days per week, and 52 weeks per year = 364
Therefore: (17.4 x 0.3) /(7 x 52) = 0.014 tpswd

Example # 2: Cumberland County Residential Wood Burning (fireplaces)
263,364 (Cumberland pop.) /1,269,775 (State pop.) = 20.74 %
167,000 (cords-statewide) x 15% x 20.74% = 5,196 cords (Cumberland County)

5,196 (cords Cumberland) x 2.336 tons/cord = 12,137 tons wood burned
12,137 tons x 229 lbs. /ton x 1 ton /2000 lbs. /ton = 1,390 tons (VOC) per year

The formula for converting tons per year (tpy) to tons per summer weekday is as follows:

(tpy x 0.3) /(7 x 52) = tpswd

Tpy = 1,390
0.3 constant EPA seasonal adjustment factor for residential fuels
7 days per week and 52 weeks per year or 364 days
(1,390 x 0.3) /(7 x 52) = 1.145 tpswd

4.1.3. STATIONARY SOURCE SOLVENT USE

The major sources (processes) of VOC emissions from the use of solvents follow:

a. Dry-cleaning
b. Surface cleaning (degreasing)
c. Surface coating
d. Graphic arts
e. Cutback & emulsified asphalt paving
f. Pesticide application
g. Commercial & consumer solvent use
h. Synthetic organic chemical storage tanks
I. Barge, tanks, tank-truck, rail car, and drum cleaning

4.1.3.1. ESTIMATION METHODS

A) Dry Cleaning

Perchloroethylene has been de-listed as a VOC. Annual registration of the dry cleaners in Maine indicates that only Perchloroethylene is used in the dry cleaning process. Therefore, no VOC emissions were calculated for this source category.

B) Surface Cleaning Operations

Description

Three basic types of surface cleaning operations are currently used: cold cleaning, vapor cleaning, and in-line or conveyorized cleaning, which can be either a cold or vapor cleaning process.

Methodology

These emissions can be estimated using EPA emission factors, which predict emissions on a per capita basis. DEP has used 1999 population data from the U.S. Census Bureau, as described in Section 2.2.3.2. Emissions for each county were calculated utilizing population and the emission factors from Chapter 4 of the EPA AP-42 guidance document. Operation for 6 days per week was assumed (i.e., 312 days per year). The following is a list of the source categories and the emission factors used:

Table 5. Pounds of VOC per Person by Category for 1999

Surface Cleaning	4.3
Automotive Repair	2.5
Manufacturing	1.1
Electronics and Electrical	0.21
Other	0.49
Cold Cleaning Degreasing	0.013

Sample Calculation

County population x emission factor = lbs. VOC per person.
Lbs. VOC per person /2000 lbs. = Tons VOC per year.
Tons VOCs per year /312 days of operation = tpswd VOCs.

Example: Cumberland County Automotive Repair
263,364 Cumberland County population for 1999 x 2.5 lbs. VOC Per person
= 658,410.75 lbs. VOC per year.
658,410.75 lbs. VOC per year /2000 lbs. Per ton = 329.205 tons VOC per year
329.205 tons VOC per year /312 days of operation = 1.06 tpswd VOC

C) Surface Coating

Description

Surface coating materials include paints, enamels, varnishes, lacquers, thinners and other product finishes. VOC emissions result from the evaporation of paint solvents and additional thinners. Substantial emissions may also result from the use of cleaning solvents both in the preparation of a surface prior to painting and in cleanup operations.

EPA provides emission factors for surface coatings on a per employee basis. We have used 1999 employment data from Tower Publishing to predict emissions. Facilities included in the point source inventory have been excluded from area source calculations in order to avoid duplication of estimates. These facility emissions were removed by subtracting them from total employment figures in the surface coating industry, as estimated by means of an *i-Steps*™ retrieval for all industries in affected SIC codes.

Methodology & Sample Calculations

Architectural Surface Coating

The method of calculating emissions for this category is discussed in EIIP Volume III, Chapter 3. Emissions for this category was calculated based on a per capita basis and have different emission factors specifically oriented for water and oil based coatings. The factor for solvent based emissions is 0.59 gallons per capita) at 3.87 lbs/VOC/gallon. For water based emission it is 1.82 gallons/capita at

0.74 lbs VOC/ gallons (table 5-2). According to Table 1.4-3 in EIIP Vol. 3, Chapter 1, the activity data for this category is 7 activity days per week. It is seasonally apportioned with 33% activity occurring in the 3rd quarter because more architectural surface coating occurs during the warmer months. Corrections for acetone, found in the solvent-based coatings, were made because emissions factors were generated prior to the de-listing of acetone as a VOC. According to table 5-4 of EIIP the solvent-based coatings contain a weight fraction of 0.032 of acetone.

Sample Calculation

1999 census population of York County = 184,527

Emissions from **solvent** coatings:

184,527 x 0.59 gal. solvent /person x 3.87 lbs. of VOC /gal. solvent = 421,329 lbs. VOC
421,329 lbs. x 0.032 lbs. acetone /lb. VOC = 13,483 lbs. acetone
421,329 lbs. VOC – 13,483 lbs. acetone = 407,847 lbs. VOC from solvent-based coatings.

Emissions from **water** coating:

184,527 (pop) x 1.82 gal. water coating /person x 0.74 lbs. VOC /gal.
= 248,520 lbs. VOC emissions from water-based coatings

407,847 + 248,520 = 656,367 lbs. of architectural surface coatings (solvent & water-based)
656,367 lbs /2000lb = 328.2 total tons of VOC

Corrected for 20% control = 328.2 x 80% = 262.5 tons
And corrected for tpswd, during ozone season = 262.5 x 0.33/91 = 0.95 tpswd

Automobile Refinishing

The method used to determine the amount of VOCs emitted from auto-body refinishing is found in EIIP, Volume III, Chapter 14, Alternate Method 1, *Apportioning National Data with Employment*. The Census Bureau Annual Business Patterns websites were used to determine a ratio of local to national employment within SIC codes. The National Annual VOC emissions in Table 13.4-1 are based upon 1998 and 1999 emissions; therefore, the total VOC emissions from this table was used (79,429.59 tpy). Total employment by this business segment is 209,140 employees in 1999 and 206,797 employees in 1998 (average of both years of 207,969 employees). The number of employees in Maine in 1999 for this business sector was 836.

Emissions were calculated using a ratio derived as follows: Tons of VOC from auto-refinishing in Maine equals tons of VOC from Auto-body refinishing on a national level multiplied by the number of employees in this industry sector in Maine, divided by the number of employees in auto-body refinishing nationally. This equaled 79,429.6 tpy of VOC. This was then multiplied by 836 employees in Maine, divided by 207,969 employees (average total employees) to give us 319.3 tpy VOC from auto body refinishing in Maine.

Many counties in Maine only listed ranges for the number of employees. Therefore, the following factors were used in determining the number of employees in each range, 2.7 in the 1-4 range, 5.3 in the 5-9 range, and 10.7 in the 10-19 range. This value was calculated (multiplied) against the number of sources in a given range. The final number of employees was rounded to the nearest integer. Tons-per-summer-weekday was based on 65 days in the third quarter, on the assumption that these businesses do not operate on weekends.

Sample Calculation

Table 6. Number of Employees per Establishment - Kennebec County

County Name	Number of Employees	Total Establishments	# of Emps. /Establishment.		
			1- 4	5-9	10-19
Kennebec	20-99	14	10	1	3

Estimated number of employees for Kennebec = 10 x 2.7 + 1 x 5.3 + 3 x 10.7
= 64 employees
64 emps x 319.3 tpy of VOC in Maine /836 employees in Maine
= 24.4 tons of VOC /yr.
24.4 tons of VOC /4 (quarters/year) /65 days = 0.094 tpswd

Traffic Markings

The method used to determine the amount of VOC emissions from this source category can be found in *EIIP, Volume III, Chapter 14, Alternative Methods* 5.1.1. The U.S. Paint sales for Traffic Markings totaling 35,309,000 gallons was obtained from *the US Census Bureau Report for Paint and Allied Products*. According to the Federal Highway Administration's annual 'Highway Statistics' report, Table HF-2, the total disbursements on roads and highways was $116,004,675,000 of which Maine spent $643,286,000. Traffic Paint was apportioned from the national level to the 'local' level by using a ratio of Maine-to-national highway spending, resulting in 195,801 gallons used by the state of Maine.

The traffic paint was apportioned using paved lane miles in each county, as obtained from the Maine Department of Transportation (MDOT). Since there was no information about the proportions of solvent-based paints used in Maine, the national average of 3.36 lb./gal was used. Using the *Speciate Profile Database* or Speciate v.3.2 (Section 7.0, Ref. 33), the totals were corrected for 4% acetone. EPA guidance in the 22 March 1995 memo from John S. Seitz, Director of Air Quality Planning & Standards, states that it is acceptable to claim a 20% reduction of these four coating categories: Architectural Coatings, Traffic Markings, High Performance Maintenance Coating, and other special-purpose coatings. This category has 20% control effectiveness, so the total VOC amount was reduced by 24% to account for acetone and control effectiveness. The seasonal activity for the ozone season is 33% of annual activity. Traffic marking application takes place 5 days per week during the active season.

Sample Calculation

U.S. Paint Sales = 35,309,000 gallons
Total money spent in U.S. for road maintenance = $116,004,675,000
Amount spent in state Maine for maintenance = $6,43,286,000
63,286,000 /116,004,675,000 = 0.005545 or 0.55%

Cumberland paved-lane-miles = 4,485.35
State total of lane-paved-miles = 37,481
4,485.35 /37,481 = 0.1197
Traffic paint usage (gal.) = 35,309,000 gal. x 0.55% = 195,788 gallons
Paint usage = 195,788 gallons x 0.12 = 23435 gallons

Conversion to tpswd of VOCs for Cumberland = 23435 gal. x 3.36 lbs. VOC /gallon
= 78742
78742 lbs. VOC /2000 lbs. = 39.4 tons of VOC x 0.76 control red = 29.9 tons of VOC
29.9 tons VOC x 0.33 seasonal activity /65 days in ozone season
= 0.15 tons per summer weekday.

Industrial Surface Coating Operations

This group contains thirteen (13) source categories, many of which used the estimation method described in Table 8.3-1 of the *EIIP Vol. III. Preferred Method for Estimating Emissions* (Section 7.0, Ref. 9). The total point source emissions were determined by polling the Maine DEP criteria inventory database for employment and seasonal activity data for certain source categories. The total emissions from the point sources contained within a given category were divided by the total number of employees at these sources. This resulted in lbs. of VOC per employee for each category, which was then compared to the national defaults.

Area source data was gathered from the *1999 Maine Manufacturing Directory*, (Tower Publishing, see Section 7.0, Ref. 4) and was split into source categories using SIC codes. This data included facility, location, county, number of employees, and of course, SIC codes. The sources were then cross-checked with the Maine DEP Toxics Inventory; and for some of the larger sources, air emission licenses were also checked. If acceptable data was reported via the toxics inventory, then these numbers were assumed to be more accurate for the most part, and were therefore, incorporated into the area source database, instead of relying on estimates generated by default emission factors. Also, if a license contained emission information that seemed more reasonable than the point source emission factor, the license emission value (licensed allowed) was used. For weekly activity, it was assumed that surface coating sources were in operation 5 days per week (or 65 days during the ozone season).

Sources that were not listed in the *1999 Maine Manufacturing Guide* were surveyed by phone. If it was not possible to make a determination as to the number of employees at each facility, then a default value of one (1) employee was assumed.

If there were no point sources in a given category, the national default emission factor was used, based on employment numbers. These national default values are listed in Table 8.5-1 of *EIIP Volume III - Area Sources* (Section 7.0, Ref. 9).

1) Furniture and Fixtures *(SIC 25).* Two (2) point sources were used to develop a VOC emission per employee number, i.e., data from two Moosehead Furniture facilities aided in the development of a factor of 640 lb. VOC per employee. It was the same order of magnitude as the national default of 944 lb. VOC per employee. Seasonal throughput for these facilities was assumed to be 25% for each quarter. A telephone survey was conducted to determine numbers of employees for industries not listed in *the 1999 Maine Manufacturing Guide.* Companies who could not be reached were considered to have only one (1) employee. Emission values were then corrected for 1.11 % acetone reduction using the Speciate Profile Database (or Speciate v.3.2, Section 7.0, Ref. 33).

2) Metal Containers *(SIC 341)* No point sources were listed for this source category in Maine, therefore the national default was used. The only source listed was Rockland Container, which may no longer be in business since they were not listed in the most recent issue of *the 1999 Maine Manufacturing Directory*. Seasonal activity was divided equally among all four quarters (i.e., 25 %). The emission values were then corrected for 1.18 % acetone reduction using the Speciate Profile Database.

3) Automobiles (new) *(SIC 3711)* Although there were several sources listed under this SIC code, it seemed more appropriate to list them under 'other transportation equipment'. The four (4) sources listed for this SIC code were Alan Berry Race Cars, FND Inc., Howard P Fairfield, and Hews Company. Hews and Howard Fairfield both fabricate snowplows while Alan Berry and FND work on specialty vehicles (race cars and automobiles respectively). None of these company processes fit the standard definition of “new” automobiles; therefore, there were no sources listed for this category.

4) Machinery and Equipment *(SIC 35*) Local emission factors were based on employee numbers reported in the *1999 Maine Manufacturing Directory.* Data from two point sources were used to develop a local emission factor of 40 lbs. of VOC emissions per employee for this area source category. These two sources were SCI Systems and Bangor & Aroostook Railroad.

Phone calls were made to companies that did not have any employment information listed in the directory. Maine DEP assumed one (1) employee for any source which could not be reached by phone. Licensed-allowed estimates were used instead of using the (local) estimated emission factor for the following companies: Fisher, The Baker Co., and General Electric-Bangor as these estimates seemed more reasonable. Final adjustments were then made to the emission estimates of Knox, York, and Penobscot counties due to these source estimates.

Actual emissions data reported via the Toxics inventory (Maine DEP) was used for Rich Tool & Die instead of the estimated emission factor number (estimated number was 4800 lbs/year, the reported number 2000 pounds/year) as it too seemed more reasonable. (Please note that the Fisher company was listed in our point source criteria inventory, but did not report any VOCs.) Their licensed-allowed VOC limit was 5.1 TPY (calculated using local emission factor 3.28 TPY) and this was used for the area source calculations. The emission values were derived by correcting for 2.89% acetone reduction using Speciate v.3.2. A seasonal activity of 25.3% was calculated for the 3rd quarter using the activity data from the point sources.

5) Appliances *(SIC 363)* There were no point sources and only four (4) area sources in this category according to the *1999 Maine Manufacturing Guide*. The national default of 463 lbs. of VOC per employee was used to estimate emissions for this category.

6) Other Transportation Equipment *(SIC 37 excluding 373)* This category included three point sources with an SIC code of 3711: Fiber Materials, Lemforder, and Pratt & Whitney. These sources were used to develop an SIC-specific emission factor of 15.5 lbs of VOC per employee. Although this is lower than the national default emission factor (of 35 lbs of VOC per employee), it was generally felt that for this category, Maine's estimated emission factor was better.

One point source reported 3rd quarter activity of 36% (during the summer months). By averaging this number with the other 2 sources and weighting the average with the number of employees, an activity factor of 25.6% was obtained.

Very few companies were missing from the *1999 Maine Manufacturing Guide*, however, an estimate of 1 employee was used for those companies which could not be contacted. The derived emission values were then corrected for 2.89% acetone reduction using Speciate v.3.2.

The following table indicates the data used to determine the local emission factor for SIC 3711 (motor vehicle & passenger car bodies) and the resultant seasonal activity factor.

Table 7. Seasonal Activity Factor for Source Industry Code 3711

Point Source	No of Employees	Lbs. of VOC	VOC /employee	Activity – 3rd Quarter	Activity Factor
Lemforder	250	49.9	0.20	25 % (or 0.25)	0.05
P&W	1610	30487	18.94	25 %	4.73
Fiber Mat	120	133.95	1.12	36 %	0.40
Total	1980	30670.85	15.49		0.256

To determine the activity factor, multiply the % seasonal activity (column 5, converted to a decimal) by the VOC per employee figure (column 4). The resultant sum of the weighted activity factors (0.256 in column 6) is then divided by the sum of the local emission factors (column 4) or more precisely:

Seasonal activity factor (summer season = 3rd quarter)
[(25 /100 x 0.2) + (25 /100 x 18.94) + (36 /100 x 1.12)**]** / (0.2 + 18.94 + 1.12) = 25.6%

7) Sheet, Strip and Coil *(SIC 3479)* Since a local emission factor could not be generated for this category, numbers of employees from the *1999 Maine Manufacturing Guide*, was used in conjunction with the national default per employee emission factor of 2877 lbs. of VOC per employee. Using this methodology the final county-totals of estimated-emissions seemed rather high, particularly since many of the businesses listed in this category were engravers. However, the resultant number was cross-checked against another methodology using a per capita default emission factor. When the overall state totals were compared, they were actually quite similar. Thus, the estimated emissions using the per employee factor method was utilized.

8) Factory Finished Wood *(SIC 2426-9, 2430-2459, 2493, 2499)* This category is one of Maine's largest. Maine has four (4) OSB plants (Oriented Strand Board) in this source category, which had a very high emission factor in lbs. of VOC per employee. Therefore, these plants were **not** used for the emission factor determination.

The remaining point sources (from Maine's Annual Emissions Inventory) were totaled along with 3 other sources (HG Winter, CF Wells and Cornwall) from the Maine Toxics Emission Inventory. An average of 221 lbs. of VOCs per employee was calculated using all of these sources. Since this factor was larger than the national default value of 131 lbs. of VOC/employees, a determination was made to compare this method with the one using licensed-allowed emissions. Comparing the county totals of the license-allowed limits to the national default and then to the derived emission factor, it was decided to use the values calculated by the local (derived) emission factor estimation method. This was largely due to the high licensed-allowed VOC emissions of several of the sources in this category. The derived emission values were then, corrected for 3.33% acetone reduction using Speciate v.3.2.

9) Electrical Insulation *(SIC 3357, 3612)* This category had no major point sources and only four (4) area-type sources. The national default of 290 lbs. VOC per employee was used for this category.

10) Marine Coatings *(SIC 373)* Five large sources were used to determine the point source emission factor for Maine, these being, the three (3) Bath Iron Works facilities, Old Town Canoe and Sabre Corporation. The calculated (local) emission factor was rounded up to 85 lbs. of VOC per employee. However, Portsmouth Naval Shipyard (in York county) was not included in this emission factor calculation as the estimated emission factor for this facility was only 7 lbs. of VOC per employee.

Actual or license-allowed estimated emissions were used for Atlantic Boats, Morris Yachts and The Hinckley Co. affecting those county estimates.

All derived emission values were then corrected for 8.51% acetone reduction using Speciate v.3.2.

11) Other Product Coatings, High Performance Maintenance Coatings, and Other Special Purpose Coatings -- The national default emission factors, based on per capita, were used for these broad source categories. For 'Other Product Coatings' the emission factor of 0.6 lbs. per person per year was used. And for the categories: 'high performance maintenance coatings' and 'other special purpose coatings' an emission factor of 0.8 VOC lbs. per person per year was used.

D) Graphic Arts

<u>Description</u>

Graphic arts include operations that are involved in the printing of newspapers, magazines, books, and other printed materials. Five printing methods are currently used: lithography, gravure, letterpress, flexography and screen-printing, and metal decorating.

Because of the number of captive graphic arts operations that are used in the industries other than printing and publishing, a per employee emission factor was found to be unreliable for estimating these emissions. Therefore, EPA's per capita emission factor of 1.3 pounds per person was used to estimate emissions from graphic arts facilities.

<u>Methodology and Sample Calculation</u>

County Population x Emission Factor = County Emissions

Example: Cumberland County

263,364 persons x 1.3 lbs. /person /year = 342,373.2 lbs. VOC per year
342,373.2 lbs. VOC per year /2,000 lbs. = 171.187 tons /year (TPY)
171.187 tpy /364 days of operation = 0.47 tons /summer weekday (tpswd)

E) Asphalt Paving

<u>Description</u>

There are three types of asphalt paving used for road paving and repair: cutback asphalt, emulsified asphalt, and hot-mix aggregates or road oils. The majority of use in Maine being the latter category, hot-mix aggregates/road oils. Emulsified asphalt is also a liquefied road surface, but is prepared with a water/soap mixture instead of petroleum distillates, and is sometimes used in Maine. Cutback asphalt is a liquefied road surface prepared by blending or "cutting back" asphalt cement with different petroleum distillates. Cutback asphalt emits more VOCs, so its use was limited to the non-ozone period of October 15 to April 15 here in Maine. However, after surveying the major asphalt producers and Maine DOT it was found that cutback asphalt is no longer used in Maine.

<u>Methodology & Data Sources</u>

According to the U.S. DOE, Maine used a total of 324 Thousand Barrels of road oils and asphalt for 1999. A combined research effort consisting of a telephone survey of the major asphalt plants and a call into Maine DOT, it was realized that only hot-mix aggregates were used. However, there was an incident where one (1) municipality used emulsified asphalt during warm weather which had not been allowed to cure before vehicles drove over it.

Guidance from EPA New England dictated that Maine use 20% of the total estimate from the U.S. DOE for the emulsified asphalt figure. Emissions were then dis-aggregated to each county level using a ratio of county VMT to statewide VMT, and then the emission factor of 9.2 lbs. of VOC per barrel was applied (per EIIP). The yearly VOC total was then apportioned to 260 workdays to determine tons per summer weekday. Calculated emissions in 1999 were lower than those stated previously in the Periodic Emission Inventory as some cutback-use was assumed in prior inventories.

Sample Calculation

- No seasonal variation assumed
- Activity = five (5) days per week
- Emission factor of 9.2 lbs. VOC /barrel

Cumberland County VMT percentage for 1999:
3,035,514,645 VMT /14,298,810,394 VMT Maine Total x 100 = 21.23%

Apportionment of DOE amount to county VMT:
324,000 Barrels x 21.23 % = 68,782.42 barrels

Emulsified Asphalt Emissions:
68,782.42 barrels x 9.2 pounds VOC per barrel = 632,798.24 pounds

Apportionment to 20% emissions
632,798.24 pounds x 20 % = 126,559.65 lbs. VOC

Conversion to tons:
126,559.65 lbs. VOC /2,000 lbs. per ton = 63.28 tons VOC

Converting to tons per summer week day:
6.3.28 tons VOC /260 workdays = 0.24 tpswd

Table 8. Asphalt Paving for Cumberland County

County	VMT	% VMT	1999 Apportionment VMT to DOE Barrels	Emulsified Asphalt Emissions (lbs.)	20% Emulsified Asphalt Emissions (lbs.)	20% Emulsified Asphalt (Ton/Year)	TPSWD (260 days per yr.)
Cumberland	3,035,514,645	21.23	68,782.42	632,798.24	126,559.65	63.28	0.24

F) Pesticide Application

Description

Pesticides include any substances used to kill insects &/or rodents or to retard the growth of fungi, weeds, or microorganisms. A number of substances may be used as pesticides including synthetic organics, petroleum solvents, &/or inorganic compounds.

According to EPA guidance (EIIP Document Series, Section 7.0, Ref. 9), the total potential VOC emissions amounted to approximately 2.45 times the amount of active ingredient in pesticides, minus the amount of active ingredient. EPA guidance led us to assume that 100% of the volume-used was in fact volatile. This methodology was employed by Maine DEP. The amount, in pounds, of pesticides used was simply divided by 2,000 to convert it to tons. Emissions were then apportioned to the county level based on land area.

Methodology

The quantities and types of pesticides used for this inventory were made available through the state Board of Pesticides Control, Maine Department of Agriculture (Section 7.0, Ref. 20).

Utilizing EPA and California databases (Section 7.0, Ref. 21), which categorized the potential of VOC emissions for pesticides, Maine DEP was able to determine VOC emissions for this area source category. By using the percentage of acreage of pesticide application, available from the U.S. Census report on Agriculture for 1996 (Section 7.0, Ref. 22), DEP was able to apportion pesticide use for each county. It was assumed that the same percentage of acreage for pesticide application occurring in 1996 was approximately the same in 1999. Seasonal apportionment (spring, summer, & fall) was 274 days.

Sample Calculation

County Acres of Pesticide Application /State Total of Pesticide Application
= Percent County acres of Pesticide Application.
Total VOC Potential emitted in Maine x percent County acreage of Pesticide Application
= VOC Emitted in County per year.
VOC Emitted in County per year x 274 days = Tons VOC per summer weekday (tpswd).

Example: Cumberland County

1,593 Acres of pesticide application in Cumberland County /118,396.0 total acres of pesticide Applied in Maine x 100 = 1.35 % Pesticide Application in Cumberland County.
172.25 Tons VOC of Pesticides applied in Maine x 100% x 1.35 % Pesticide
= 2.32 Tons VOCs from Pesticide Application in Cumberland County.
2.32 Tons VOC /274 Days of Application = 0.01 tons per summer weekday (tpswd)

G) Commercial/Consumer Solvent Use

Description

This area source category includes an assortment of activities that focused on residential and commercial use of solvent-based products that emit VOCs when used.

Methodology

The emissions for commercial and consumer solvent use can be estimated using EPA emission factors that predict emissions on a per capita basis. DEP used 1999 population data from the U.S. Census Bureau as described in Section 2.2.3.2. in predicting emissions. Emissions for each county were calculated using U.S. Bureau of Census population estimates along with emission factors supplied bythe EIIP Document Series, Volume III, Chapter 5 (Section 7.0, Ref. 9). The following is a list of the emission factors used for each source category:

Table 9. Commercial /Consumer Solvent Use

Source Category	Per capita emission factor (lbs. VOC/person) (c)
Consumer & Commercial Solvent Use	(7.84 = Total in lbs.VOC /Person)
Personal Care Products *	2.32
Household Products *	0.79
Automotive after-market Products*	1.36
Adhesives and Sealants	0.57
FIFRA-Regulated Products	1.78
Coatings and Related Products	0.95
Miscellaneous Products	0.07

(c) Compounds listed as non-reactive by EPA, April 1996, have been excluded. A significant change to earlier derivations was the removal of acetone from the list of reactive VOCs.
* Further reductions of 20% applied to these subcategories per EPA New England, Memorandum 6/22/95.

Sample Calculation

County population x emission factor = lbs. VOC per person.
Lbs. VOC per person /2000 lbs. = Tons VOC per year.
Tons VOCs per year /364 days of use = tpswd VOCs.

County Population x Emission Factor = County Emissions

Example: Cumberland County – Personal Care Products for 1999:

263,364 Cumberland County population for 1999 x 2.32 lbs. VOC Per person
= 611,004.48 lbs. VOC per year.
611,004.48 lbs. VOC per year /2000 lbs. per ton = 305.5 tons VOC per year
305.5 tpy x 0.2 = 61.1 VOC reduction
305.5 - 61.1 VOC reduction = 244.4 tons VOC
244.4 tons VOC per year /364 days = 0.67 tpswd VOC

H) Synthetic Organic Chemical Storage Tanks

AP-42 provides detailed methods for calculating emission factors when estimating emissions from synthetic organic compound (SOC) storage. Since little additional information was obtainable for this category, the estimated emissions were not thoroughly evaluated as they could very well be zero or at least deemed insignificant. If organic chemical storage tanks exist in the state, more than likely they are already included in the point source inventory.

I) Barge, Tank, Tank Truck, Rail Car, & Drum Cleaning

Cleaning the equipment used in the transport and storage of a variety of chemicals may also result in emissions of VOC, NOx, and PM10. Emission types and levels depend on the commodity transported, cleaning agents, and the management of chemical residues. Emissions associated with chemical residue depend upon the quantity of compounds remaining in the container.

AP-42 breaks down the major commodity groups and frequency of tank-car cleaning and lists VOC emission factors for several cleaning agents. Perhaps through field testing, better emission factors might be compiled for all classes of cleaning agents, pollutants emitted, or for general classes of commodities transported. Since little information has been compiled for this category, estimated emissions were not evaluated nor weighted.

4.1.4. BIO-PROCESS SOURCES

Bio-process emissions sources include sources whose emissions result from biological processes (e.g., fermentation). Source categories located in Maine include the following:

a. Bakeries
b. Breweries
c. Wineries
d. Distilleries

4.1.4.1. ESTIMATION METHODS

A) Bakeries

<u>Description</u>

Bakeries emit VOCs during the baking process, primarily ethanol formed by yeast fermentation.

<u>Methodology</u>

The principal means of data collection is through use of questionnaires or phone surveys. Total VOC emissions from bakeries may be estimated once the total tonnage of bread baked and process type (sponge or straight dough) is ascertained. Emission factors are then applied using estimating techniques similar to the development of the 1990 Base Year Emissions Inventory (Section 7.0, Ref. 1, p. 51).

In our research, we discovered some facilities whose emissions exceeded 50 tons per year. These facilities were added to the point source inventory rather than being counted in the area source portion. The remaining facilities were inventoried as area sources. Using the Radian Corporation (Section 7.0 Ref. 36) guidance to calculate ozone season daily emissions, which suggests an emission factor of 0.11 tons of VOC per employee per year, it was assumed that operations were conducted uniformly year-round using a six-day workweek.

Sample Calculation

Point Sources: Production (tons) x Emission Factor = Point Emissions

Where the Emission Factor = $0.95\ Y_i + 0.195\ t_i - 0.51\ S - 0.86\ t_i + 1.90$

Y_i = initial yeast as a % of flour

t_i = total ferment time in hours

S = spike time in hours

Area Sources: County Employment - County Point Employment = County Area Employment

County Area Employment x Emission Factor = County Area Emissions

Example: Cumberland County

Point Sources = 53 tons per year or 53 /(6 x 52) = 0.17 tpswd

Area Sources = 557 total employees - 400 point employees

= 157 county area employees

157 employees x 0.11 tons /employee = 17.27 tons per yr. or 17.27 /(6 x 52) = 0.05 tpswd

B) Breweries

Breweries emit VOC at various stages of the brewing process; therefore, emission estimates were based on the total number of barrels produced in the inventory year. Normally, this information would be gathered via a telephone survey of the local breweries. However, in 1993 the "total barrels" value was used with the Radian Corp. VOC emissions factor of 58.8 lbs/1000 barrels to arrive at the estimated Statewide VOC emissions of 0.00878 tpswd. For our inventory purposes, this amount was deemed negligible. Even with the highest growth factor supplied by EGAS - for the year 2006, the Statewide total only increased to 0.00105 tpswd. Assuming that emissions occur seven days a week, the pounds of VOC per summer weekday from breweries was determined to be insignificant across the State and were not assessed for 1999.

C) Wineries

During wine fermentation, ethanol is released whenever wine is exposed to air. Factors affecting ethanol emissions include fermenting parameters, process equipment design, handling techniques, and temperatures. Because red and white wines are fermented at different temperatures, red wine results in higher emission rates. The emission factors for wine production, provided by the 1990 Base Year Inventory documentation, and estimates from Bartlett Winery (Hancock County) determined at that time, a production of 9000 gallons of white wine along with 6000 gallons of red wine. Applying emission factors to these numbers yielded a total of 49 pounds of VOCs for calendar year 1990. Assuming the fermentation process occurs year-round, the daily VOC emissions from wineries would amount to 0.13 lbs/day, which is negligible in the overall inventory and was therefore, not included for this (1999) inventory.

D) Distilleries

The principal VOCs emitted from distilleries also comes from ethanol. In contacting White Rock Distillery, the state's only known distillery, it was reported that no alcohol was actually made on the premises. However, some product was stored locally, so an estimate of the amount of alcohol stored on-site was made.

In the past, emissions were calculated by using emission factors from AP-42 Section 4.3-1, (Section 7.0, Ref. 7, pp. 4.3-5 & 4.3-8) for the storage of organic liquids, hence, the VOC loss from storage of alcohol could be estimated. In the absence of better data, it was assumed that emissions were consistent throughout the year and not necessarily production related. So, due to the small number of estimated emissions, as determined by the 1990 base year inventory, no estimate was made for this category in 1999.

4.1.5. CATASTROPHIC/ACCIDENTAL RELEASES

Sources in the catastrophic/accidental release category represent unplanned, unintentional emission releases associated with evaporative or combustible materials. Source categories include rail-car, tank truck, and industrial accidents; natural gas well blowouts; and oil spills.

DEP assumes that accidents occur randomly, and that they are spread more or less uniformly throughout the year. Thus, ozone seasonal daily emissions represent a year-round, seven days per week, activity level. Emissions have been apportioned to counties based on population for 1999.

4.1.5.1. ESTIMATION METHODS

A) Oil Spills

Description

Oil spills involve oil-tanker accidents, tanker-truck accidents, and blowouts from rigs or pipelines. The nature and quantity of emissions from oil spills can be highly variable; emissions may also be influenced by the clean up procedure or by dispersion and weathering processes. Evaporation of spills causes local VOC emissions. If spills catch fire, additional SO_2, CO, CO_2, PM, NO_X, and VOC emissions may result.

Methodology

The Air Bureau has assumed that all material spilled was released as VOCs. Additionally, a constant density of 6.54 lbs/gal spilled was assumed. This relates to the average density of the petroleum materials shipped into state which carry a likelihood of spillage. Using these assumptions with data from the Bureau of Oil and Hazardous Waste's Response Division, VOC emissions were estimated. This activity was assumed to be spread evenly throughout the year, as accidents are not generally restricted to any one season.

<u>Sample Calculation</u>

Total Petroleum Spilled x % Population in County = Petroleum Spilled in County
Petroleum Spilled in County x Density x % Volatility = County VOC Emissions
Total Petroleum Spilled x % Population in County = Petroleum Spilled in County
Petroleum Spilled in County x Density x % Volatility = County VOC Emissions

Example: Cumberland County

112,267.47 gallons x 21% = 23,272.97 gallons
23,272.97 gallons x 100% x 6.54 lbs. /gallon x 1 ton /2,000 lbs.
= 76.10 tons
Tons per summer weekday = 76.10 tons /364 days = 0.21 tpswd.

B) Rail Car, Tank Truck & Industrial Accidents

Catastrophic releases of hazardous materials other than petroleum products make up this category of emissions. Chemical spills from rail car, tank-truck, or industrial accidents may happen with or without combustion, so the emissions depend upon the nature and quantity of material(s) released. However, if combustion occurs, VOC, NOx, CO, and air toxics releases, may result. Very little information was found for this category, consequently emissions were not evaluated.

4.1.6. SOLID WASTE INCINERATION

4.1.6.1. ESTIMATION METHODS

A) On-site Incineration

<u>Description</u>

All facilities reported to be incinerating waste were included in the point source inventory and were omitted from the area source emissions calculations to avoid duplication.

On-site incineration was the confined burning of solid waste by such institutions as hospitals, nursing homes, large apartment complexes, veterinary offices, funeral homes and laboratories. Large-scale incineration (municipal solid waste, e.g.) was included in the point source inventory. In order to quantify emissions from like sources, the on-site incineration category was further broken down into two sub-categories, apartment waste incineration and medical waste incineration.

<u>Methodology & Sample Calculation</u>

1) Apartment Waste Incineration:
State regulations of the Department of Environmental Protection (Title 38, MRSA, Chapter 115) requires that solid waste incinerators with a total heat input of greater than one (1) million BTUs obtain an air emission license prior to operation. There is currently only one licensed apartment waste incinerator in Maine. This facility was contacted via telephone and reported approximately 12.2 tons of residential waste burned for 1999. This tonnage was then multiplied by emission factors from EIIP (Section 7.0 Ref. 9). According to facility staff, incineration is operated automatically at twice day

intervals for twenty minutes each, including weekends.

Example: VOC York County

12.2 Tons Waste x 3 Lbs./Ton) /2000 = 0.0183 Tons VOC
0.0183 Tons VOC x 0.25 /91 Days = 0.00005 tpswd VOC

2) Medical Waste Incineration:
Medical waste incineration includes the burning of wastes produced by hospitals, veterinary facilities, crematoriums, and medical research facilities. In order to generate county values in 1999 for tonnage of waste burned, all hospitals, crematoriums, and medical research facilities were contacted through a telephone survey. Data obtained from crematoriums was in the form of bodies incinerated per year. In order to convert this value to mass, the number of bodies was multiplied by a statewide percentage of sex then by the average human body weight for men and for women.

Due to the large number of veterinary incinerators in-state, data was generated three different ways: (1) from the most recent license application, (2) via telephone survey, and/or (3) a facility average. The Department's air emission licensing section recently began an inquiry into the actual mass burned for these types of facilities over a calendar year as part of the license renewal application. Sixteen (16) out of twenty-eight (28) facilities reported information this way, covering about 57% of the veterinary facilities in Maine. Another eight (8) facilities, encompassing about 29%, were reached via a telephone survey. The remaining four (4) facilities (amounting to about 14%) were not included as they could not be reached or estimated. Therefore, an average of 9.42 tons of animal mass per year was utilized as a surrogate estimate.

Example: VOC Cumberland County

(59.7 Tons Medical Waste x 0.299 Lbs./Ton) /2000 = 0.009 Tons VOC
0.009 Tons VOC x 0.25 /91 Days = 0.00002 tpswd VOC

Table 10. Solid Waste Incineration - Cumberland County
Emission Factors in lbs./ton.

Source	VOC	NOx	CO
Apartment Waste	3	3	10
Medical Waste	0.299	3.56	2.95

E) Open Burning

Description

This area source category includes the burning of household rubbish, yard waste, and land clearing debris due to construction. Typically this type of burning is done in an exposed pile or barrel open to the air with no controls of the combustion process or of emissions as with pollution control devices.

Methodology

1) Residential Waste

In 1997 the Maine Department of Conservation Forestry Bureau surveyed town fire wardens and state forest fire rangers about the degree of backyard burning (BYB) in each town or groups of townships throughout Maine. The survey estimated that 7,665 tons of waste was burned in approximately 8,510 backyard trash incinerators throughout the state of Maine. Using a ratio between 1997 and 1999 population totals, the number of burn barrels (8,777) and waste tonnage (7,906) was then estimated for 1999 (Section 7.0, Ref. 23). The total residential-waste tonnage was then apportioned by county based on a percentage of total burn-barrels in each county. Emission factors from *AP-42* (Volume 1, Chapter 2.5) were applied to the total tonnage of waste to estimate emissions for carbon monoxide (CO) and nitrogen oxides (NOx). In order to estimate VOC emissions from backyard burning, the total waste tonnage was multiplied by a composite emission factor taken from the EPA technical report: *Evaluation of Emissions from the Open Burning of Household Waste in Barrels* (Section 7.0, Ref. 24). Results from four barrel burns (conducted to represent the waste generation of both avid recyclers and non-recyclers) were averaged to develop the VOC emission factors.

Example: Residential Waste

1997 Barrels /1997 Population x 1999 Population = 1999 Barrels
1997 Tonnage /1997 Barrels x 1999 Barrels = 1999 Tonnage
1999 Tonnage x Emission Factor = Emissions

2) **Yard Waste**

Currently no state-specific activity data exists for yard waste burning in Maine. Therefore, a "top-down" approach, similar to EPA's National Emission Inventory (NEI), was used to estimate yard waste tonnage for 1999. A per capita waste generation value of 0.1 tons yard waste/person/year (0.57 lbs yard-waste/person/day) was used to estimate total yard waste tonnage for all counties (Section 7.0, Ref. 26). Using EIIP guidance (Section 7.0, Ref. 9, Volume III, Chap. 16 – Open Burning), it was assumed that total yard waste consists of 25 % leaves, 25 % brush, and 50 % grass, on the average, and that grass clippings are usually not collected and burned. The tonnage for brush and leaves was then adjusted to represent a portion of waste actually burned. EPA estimated that 28 % of total yard waste was burned. Emission factors from EIIP were then multiplied by the remaining tonnage for both grass and brush.

Example: Residential Yard Waste

Population x 0.1 tons /person /year = Waste Generated
Waste Generated x 0.25 x 0.28 = Tons Leaves Burned
Waste Generated x 0.25 x 0.28 = Tons Brush Burned
Waste Burned x Emission Factor = Emissions

3) Land Clearing Debris

In order to estimate emissions from land clearing, the number of acres cleared within the inventory area must first be determined. Since no state-specific activity data exists for land clearing in Maine, a top-down approach was again employed in order to estimate the amount of disturbed acreage for the three subcategories involved in land clearing, i.e., residential construction, nonresidential construction, and roadway construction.

a.) Residential Construction - includes single-family and two-family structures, and apartments. The number of housing permits issued per county was obtained from the U.S. Department of Commerce (DOC), Bureau of the Census (Section 7.0, Ref. 10). The NEI methodology assumed that the total acres of disturbed land from residential construction could be estimated by using the factors below:

Single Family – 0.25 acre /building
Two family – 0.33 acre /building
Apartment – 0.50 acre /building

The Bureau of Census reported building permits in increments of single family, two family, and three, four, & five family dwellings or more. All three or more family housing units were considered apartments.

b.) Nonresidential Construction - is calculated using the value of construction put in place of the cleared land. Statewide values of nonresidential construction was obtained from the 1997 Economic Census (Section 7.0, Ref. 28) and proportioned to counties based on population. Acreage was then estimated using a NEI conversion factor of 1.6 acres/10^6 dollars.

c.) Road Construction - values for highways and streets was included in the 1997 Economic Census. NEI methodology used a conversion factor of $1.9 million per mile for all non-freeway and interstate projects, and $4 million per mile for all freeway and interstate projects. Since the actual break down of road construction was unknown, the more conservative estimate of $1.9 million per mile was used. Road mileage can then be converted to acreage using the following NEI assumptions for the different road types (interstate, urban & rural):

Other arterial, urban = 15.2 acres /mile
Other arterial, rural = 12.7 acres /mile
Collectors, urban = 9.8 acres /mile
Collectors, rural = 7.9 acres /mile

Again, the construction breakdown was not known, therefore an average factor of 11.4 acres/mile was employed. The total acreage was then apportioned to counties based on population.

The acreage of land cleared from each subcategory was added together to get a total land area estimate for each county. The land area was then multiplied by the percent of forested land and by the percent of grasslands within each county. The land use percentages for forested land and grasslands (agricultural land + rangeland) were derived from county delineated data using *Anderson Land Use Codes* (Section 7.0, Ref. 39).

Forested land was then further adjusted to represent the relative mix of hardwood versus softwood, based on Forest Service estimates. It was determined that the Maine woods are about 58.8 % conifer and 41.2 % hardwood. An assumption was made that conifers were 50% long needle and 50% short needle types. Thus, the total percentages of the woodlands became 41.2 % hardwood, 29.4 % long-needle conifer and 29.4 % short-needle conifer.

Once the total acreage for cleared land was determined for every county then the following NEI fuel loading factors were applied:

> Hardwood = 99 tons acre,
> Softwood = 57 tons /acre,
> Grass = 4.5 tons /acre.

Much of the debris from land clearing in Maine is either chipped for pulp or for biomass burning, or was hauled away as timber. In order to determine the amount of debris actually burned, it was estimated that 2.63 % of the total debris from land clearing was burned or dumped in rural areas (Section 7.0, Ref. 29). Since the prevalence of rural dumping is unknown, it was assumed that all remaining debris was burned.

Finally, emission factors for open burning from EIIP (Section 7.0, Ref. 9) and CARB (Section 7.0, Ref. 30) were applied to the three fuel types.

Example: Land Clearing Debris:

Residential Construction Acres Cleared + Nonresidential Construction Acres Cleared + Road Construction Acres Cleared = Total Acres Cleared

Hardwood:
Total Acres Cleared x % Forestland x % Hardwood x Fuel Loading Factor x 2.63% x Emission Factor = Emissions

Softwood:
Total Acres Cleared x % Forestland x % Softwood x % Short or Long-Needle x Fuel Loading Factor x 2.63 % x Emission Factor = Emissions

Grass:
Total Acres Cleared x Fuel Loading Factor x % Grassland x 2.63% x Emission Factor = Emissions

Total Emissions = Hardwood + Softwood + Grass

4.1.7. OTHER STATIONARY AREA SOURCES

Other stationary area sources include forest fires, slash and prescribed burning, agricultural burning, structure fires, orchard heaters, and leaking underground storage tanks. Although intermittent in nature, these sources can produce large quantities of air pollutant emissions. Some of these area source activities, such as orchard heaters and certain kinds of agricultural burning do not occur during the oxidant season.

4.1.7.1. ESTIMATION METHODS

A) Forest Fires

Description & Methodology

Forest Fires can produce very large, short term organic emissions in rural areas. The data on forest fires came from the Fire Control Division of the Maine Forest Service (Section 7.0, Ref. 39) who provided the total number of acreage burned for each forest fire. Then, using AP-42 fuel loading emission factors (Section 7.0 Ref. 6: *Volume 1, Chapter 13.1 Wildfires and Prescribed Burning)*, emissions could be ascertained.

According to local fire officials, emissions are generally restricted to spring, summer, and fall, though the number of fires in each season varies annually. Thus, a seasonal adjustment factor of 1.3 has been used, assuming that occurrences of fires were distributed evenly among the three seasons. Since these occurrences are irregular and unpredictable, seven (7) days per week was assumed for an activity level.

Sample Calculation

Acres Burned in County x Loading Factor = Tons Material Burned in County
Tons Material Burned in County x Emission Factor = Emissions

Example: VOC Cumberland County

13.7 Acres x 11 tons /acre = 150.7 Tons
(150.7 Tons x 24 Lbs. /Ton) /2000 = 1.808 Tons VOC
1.808 x 0.33 /91 days = 0.007 Tpswd VOC

Table 11. Forest Fires in Cumberland County
Emission Factors (lbs./ton)

Area Source Category	VOC	NOX	CO
Forest Fires	24	4	140

B) Slash-Burning & Prescribed-Burning

Description

Waste produced by logging operations, and burning operations under controlled conditions (a.k.a. prescribed-burning) may result in criteria air pollutant emissions. The Fire Control Division of the Maine Forest Service provided information pertaining to the number of acres burned by these fires in 1990. Unfortunately, this data was not available for 1999. Because of this inventory constraint the 1990 numbers were employed to estimate 1999 figures using apportionment techniques. Future emission inventories will require further investigation into the slash and prescribed-burning activity within Maine.

Methodology

Since it is unknown for sure how slash or prescribed burning activity relates to population or even to forest density, the 1990 totals were apportioned to the county-level based on land area. Using the fuel loading factors from AP-42 (Section 7.0, Ref. 6, Chapter 13.1) and guidance from EIIP (Section 7.0, Ref. 9: Vol. III, Chapter 16), along with the regional configuration-percentages for North Central and Eastern prescribed burning activities, the tons of material burned was able to be estimated for all counties. Emission factors from AP-42 and the California Air Resources Board, better known as CARB, (Section 7.0, Ref. 30) were then applied for all prescribed-burning fuel types.

Since the fuel percentages for the logging-slash category were adjusted based on Forest Service estimates; that being, the Maine woods were estimated to be 58.8% conifer and 41.2% hardwood, DEP had to make some assumptions in order to estimate the sub-category numbers. Therefore, for the purpose of emissions factoring it was assumed that long-needle conifers made up half of the conifer population while the other half was comprised of the short-needle types. Thus, assuming the logging-slash fuel-type accounts for approximately 50% of the total fuel for the entire slash/prescribed-burning category, the total fuel percentage resulted in the following: 20.6% hardwood slash, 14.7% long-needle conifer slash, 14.7% short-needle conifer slash, 30% grassland, 10% underburning of pine, and 10% other. Emission factors could then be derived for the logging-slash category by using these weighted-factors and thereby arriving at a cumulative total for all wood types. The following example displays emission factors, fuel loading factors, and regional fuel loading configurations for the slash/prescribed-burning category.

<u>Sample Calculation</u>

Acres Burned Statewide x % Land Area in County = Acres Burned in County
Acres Burned in County x Loading Factor = Tons Burned in County
Tons Burned in County x Emission Factor = County Emissions

Example: VOC Cumberland County

1274 Acres x 2.7% Land Area = 34.4 Acres Burned in Cumberland County
(34.4 Acres x 20.6% x 12 ton/acre x 12.8 Lbs. /Ton VOC) /2000
+ (34.4 Acres x 14.7% x 10 ton/acre x 7.0 Lbs. /Ton VOC) /2000
+ (34.4 Acres x 14.7% x 10ton/acre x 8.4 Lbs. /Ton VOC) /2000
+ (34.4 Acres x 30% x 2 ton/acre x 10.7 Lbs. /Ton VOC) /2000
+ (34.4 Acres x 10% x 10 ton/acre x 9.8 Lbs. /Ton VOC) /2000
+ (34.4 Acres x 10% x 11 ton/acre x 18 Lbs. /Ton VOC) /2000
= 1.6 Tons VOC
1.6 Tons VOC x 0.25 /91 Days = 0.004 Tpswd VOC

Table 12. Slash & Prescribed-Burning for Cumberland County
Fuel Percentages & Emission Factors

FUEL TYPE	FUEL LOADING		POLLUTANT (lbs./ton)		
Categories	**% of Fuel**	**Tons/Acre**	**VOC**	**NOX**	**CO**
Logging Slash*	**50**	**32**	**28.2**	**10.5**	**828.0**
Hardwood	20.6	12	12.8	3.5	224.0
Short-Needle Conifer	14.7	10	7.0	3.5	350.0
Long-Needle Conifer	14.7	10	8.4	3.5	254.0
Grassland	**30**	**2**	**10.7**	**4.5**	**114.0**
Underburning-pine	**10**	**10**	**9.8**	**3.0**	**332.9**
Other	**10**	**11**	**18.0**	**3.5**	**355.8**
*Based on a fuel percentage of 50% for the Logging-slash category					

C) Agricultural Burning

Description & Methodology

AP-42 contains emission factors that may be used to predict agricultural-burning emission-statistics. Agricultural land burned data was obtained from a contact at the Maine Department of Agriculture (Section 7.0, Ref. 36). Since the principal burning activity conducted for blueberry fields occurs in the springtime and there is no other burning activity in this source category during the ozone season throughout Maine, then ozone season daily emissions were estimated to be zero.

In order to estimate annual emissions for blueberry burning, emission factors from CARB (Section 7.0, Ref. 30) were applied using a fuel loading factor of 2 from AP-42 (Section 7.0, Ref. 6: Vol. 1, Chapter 2.5: Open Burning). Since specific emission factors for blueberry burning does not exist, factors constituting an average of field crops was employed.

Sample Calculation

Example: VOC Washington County

7320 Acres Burned /year x 2 tons /acre = 14,640 Tons Burned per year
(14,640 Tons x 10.7 Lbs./Ton) /2000 = 78.3 Tons VOC annually

Table 13. Agricultural Burning in Washington County
Emission Factors in lbs./ton

Source Category	VOC	NOX	CO
Agricultural Burning	11	4.5	114

D) Structure Fires

Description & Methodology

Emissions from structure fires were estimated using data obtained from the Maine Fire Marshall's Office, i.e., the number of structure-fires reported by local fire departments. The total numbers of fires were then summarized and apportioned to their respective counties. Using this data along with the EPA fuel loading factor of 1.15 tons of material per fire, along with the emission factors from EIIP guidance (Section 7.0, Ref. 9), county emission estimates could then be determined.

Emissions from this type of accidental-category are generally assumed to occur uniformly throughout the year.

Sample Calculation

Fires in County x Fuel Loading Factor = Tons Material Burned
Tons Material Burned x Emission Factor = Emissions

Example: VOC Cumberland County
290 Fires x 1.15 Tons /Fire = 333.5 Tons
(333.5 x 11 Lbs. /Ton VOC) /2000 = 1.83 Tons VOC
1.83 Tons VOC x 0.25 /91 Days = 0.005 tpswd

Table 14. Structure Fires in Cumberland County
Emission Factors (lb./ton)

Source Category	VOC	NOX	CO
Structure Fires	11	1.4	60

E) Vehicle Fires

Description & Methodology

In order to calculate emissions from vehicle fires, an EPA fuel-loading factor of 500 lbs. per fire was applied to fire data obtained from the Maine State Fire Marshals Office. Emissions of NOx and CO were then estimated using factors from *EIIP*. VOC was estimated using the Non-methane TOC factor. Since there is no clear way to estimate the reactive portion of Non-methane TOC, it is assumed that all NMOC are VOC.

Sample Calculation

Example: VOC Cumberland County

(266 Fires x 500 Lbs. /Fire) /2000 = 66.5 Tons

(66.5 Tons x 32 Lbs. /Ton VOC) /2000 = 1.06 Tons

1.06 Tons x 0.25 /91 Days = 0.003 Tpswd

Table 15. Vehicle Fires in Cumberland County
Emission Factors in lbs./ton

Category Source	TOC	NOX	CO
Vehicle Fires	32	125	4

F) Orchard Heaters

The Maine Department of Agriculture informs us that no orchard heaters were employed in the state of Maine. Therefore, annual or seasonal emissions are zero.

G) Leaking Underground Storage Tanks

Description & Methodology

VOC emissions (in addition to other pollutants) emanate from leaking underground storage tanks. Radian guidance indicated that emissions could be calculated when the occurrences of tank remediation in the inventory year are known. Using this number in conjunction with an emission factor provided by Radian (of 28 lbs. /event /summer weekday), county emissions were determined (Section 7.0, Ref. 37).

Sample Calculation

1990 County remediation x Emission Factor = County Emissions

1999 County remediation x 28 lbs. VOC /event /summer weekday /2000 pounds = Tons VOC

Tons VOC /365 = VOC tpswd

Example: Cumberland County

10 remediation x 28 lbs. VOC = 280 lbs. VOC

280 lbs. VOC /2,000 tons per Lbs. = 0.14 Tons VOC per year.

0.14 Tons VOC per year /365 days per year = 0.00038 tpswd

5.0. MOBILE SOURCES

5.1. HIGHWAY MOBILE SOURCES

The highway portion of the emission inventory was developed through the use of EPA's mobile source emission factor model MOBILE 6.0 (Section 7.0, Ref. 5). In the 1999 inventory, all emissions were calculated and reported as typical summer day emissions. State-specific travel information was provided by the Maine Department of Transportation (MDOT) and was used in conjunction with MOBILE 6.0 to calculate Maine's on–road emissions.

5.1.1. ESTIMATION METHODS

The process used for calculating mobile source emissions involved the use of VMT (vehicle miles traveled) data for the state. The VMT data, compiled by MDOT, was provided to the Air Bureau from data maintained in their TINIS database (Transportation Integrated Network Information System). The VMT data was arranged by roadway functional class and speed categories for each county in Maine. Each functional class could then be associated with a certain speed in the MOBILE 6.0 model. The model provided emission factors for four (4) different roadway types (freeway, arterial, local, and freeway ramp) at selected speeds.

5.1.1.1. CALCULATIONS OF THE VMT MIX

Maine DOT provided the DEP with a computer printout of *1999 Travel Activity by Vehicle Type and Functional System*. This data included eight (8) vehicle types. The data then had to be split into the sixteen (16) different vehicle classes considered by the MOBILE 6.0 model, using data from EPA's *Travel Activity by Vehicle Type* table (M6_Utility.xls), which is a piece of the MOBILE 6.0 model, resulting in a percent-of-travel for each vehicle type. Using this estimate of 1999 percent-of-travel data and the travel activity by vehicle type, the VMT mix for each roadway class in Maine could be determined.

An example of the VMT mix calculation for Passenger Cars is as follows:

(% Travel for DOT vehicle class) x (% of that Travel equal to mobile source vehicle type)
= VMT mix for specific roadway functional class

Maine DOT provided information on the *Summer Adjusted 1999 Daily VMT by Estimated Speed.* This data was based on an annual average daily-traffic-count along various lengths of roadway (called links) for each county. It was then broken-down into roadway functional class categories.

5.1.1.2. ESTIMATED EMISSIONS FROM MOBILE SOURCES

On-road (i.e., highway) mobile source emissions of VOC, nitrous oxides (NO_x) and carbon monoxide (CO), were calculated from the VMT data using emission factors derived from MOBILE 6.0 for all counties for a typical summer day. The emission factors were based on grams of pollutant, per mile of travel, for each speed and roadway type. The all-vehicle emission factors (a composite emission factor, weighted by a percentage of vehicle types that make up the vehicle-miles-traveled) were multiplied by the VMT associated with the specific speed and functional class, to arrive at emissions in grams. These emissions were then converted to tons (by multiplying the number of grams by the conversion factor of 907,184.86 g. /ton) and reported as tons per summer weekday. The MOBILE 6.0 model may also be used to calculate vehicle-refueling emissions in grams per mile. Maine chose to include the refueling emissions as part of the on-highway mobile estimates.

Additional variables in the MOBILE 6.0 model include ambient temperature and Reid Vapor Pressure (RVP), which is a measure of the volatility of gasoline used in-state. Two different RVP values were used in developing this inventory, 7.8 for the seven southern (non-attainment) counties of York, Cumberland, Sagadahoc, Knox, Lincoln, Androscoggin, and Kennebec and an of RVP 9.0 for all other counties.

Stage-II vapor recovery is a control measure that was applied to York, Cumberland and Sagadahoc counties (moderate non-attainment area 1), while the National Low Emission Vehicle (NLEV) program was applied statewide.

Modeling for Cumberland County also included both an Anti-Tampering program (ATP), which is a check for the presence of a catalyst and gas cap, and a program called I/M for Inspection and Maintenance. The I/M program monitors evaporative gas-cap pressure losses from light-duty gasoline powered vehicles built after 1973.

5.2. OFF-HIGHWAY MOBILE SOURCES (Or Other Non-Road Engines and Vehicles)

The "Other Non-road Engines and Vehicles" category includes a diverse collection of equipment ranging form lawnmowers and chain saws, to recreational equipment, farm equipment and construction machinery. The EPA conducted a study of emissions from non-road engines and vehicles, completed in November 1991, to determine whether emissions from these sources cause, or significantly contribute to air pollution that may be reasonably anticipated to endanger public health or welfare.

5.2.1. ESTIMATION METHODS

As part of the off-highway mobile study, EPA considered more than 80 different types of equipment. To facilitate analysis and reporting, the equipment types were grouped into 10 equipment categories:

Lawn and garden	Construction
Agricultural	Airport Service
Logging	Recreational
Light Commercial	Recreational Marine
Industrial	Commercial Marine Vessels*

* In this inventory, the Commercial Marine Vessels category was treated and discussed separately.

Non-road equipment emissions for 1999 were calculated using a draft EPA non-road model. The draft version of the model has the capacity to estimate emissions for more than eighty (80) basic types and about two-hundred and sixty (260) specific types of non-road equipment, excluding aircraft, commercial marine, and railroad locomotive sources. Fuel-types included gasoline, diesel, compressed natural gas (CNG), and liquefied petroleum gas (LPG).

Model input data for fuel RVP and percent-sulfur were obtained from the Mobile Source Section of the

Maine DEP. Historical temperature data for most counties were obtained from the Caribou National Weather Service on the web at: http://205.156.54.206/er/car/

5.3. AIRCRAFT

Aircraft may be broadly categorized as either civil or military aircraft. Civil aircraft, according to EPA guidance (Section 7.0, Ref. 40), includes all categories of fixed or rotary-wing craft from the smallest single engines to the largest commercial aircraft, either privately owned or privately operated.

5.3.1. ESTIMATION METHODS

For the purposes of emission-estimation, aircraft was further categorized into four major groups: commercial, general aviation, air taxi, and military aircraft. Commercial aviation includes all aircraft used for scheduled passenger transportation, freight, or both. Air taxis, used for similar operations, are generally smaller and operate on a much more limited basis than the commercial carriers. The general aviation group includes all non-military rotary-wing (helicopters) and most fixed-wing aircraft used for recreational flying or for business and/or personal transportation, and other activities. Military aircraft was categorized as aircraft used for national defense and military support.

Aircraft emissions were calculated differently for each of the aviation groups defined above. In each case, LTO (landing and take-off) cycles serve as the sole source of activity data in the estimation process. Operational data for all aircraft groups at FAA-towered airports, federally-contracted towered airports, nonfederal towered airports, and many non-towered airports was obtained using the FAA Terminal Area Forecast System (FAA-TAF, Section 7.0, Ref. 40). Additional data (departures by aircraft model) for airports which support commercial aircraft activity (Bangor International & Portland International Jetports only) were obtained from the U.S. Department of Transportation, Bureau of Transportation Statistics, Office of Airline Information. Finally, data regarding military aircraft operations at Brunswick Naval Air Station (BNAS) were obtained directly from Navy personnel.

Emissions from general aviation, air taxi, and military aircraft were estimated by multiplying the number of LTO cycles by the composite emission factors listed in *Procedures of Emission Inventory Preparation, Volume IV: Mobile Sources* (Section 7.0, Ref. 9.d). Correction values for each aircraft type were then applied to total HC to obtain an estimate for VOC.

To quantify emissions from commercial aircraft at Portland International Jetport and Bangor International Airport, LTO and aircraft data was entered into the FAA Aircraft Engine Emission Database (FAEED, Section 7.0, Ref. 40). Default values for 'time-in-mode' and engine type were selected for each aircraft type. Emissions from aircraft not included in FAEED were calculated by generating composite emission factors from the commercial fleet mix at each airport. Again, correction values were applied to total hydrocarbon (HC) figures to obtain an estimate for VOC.

Table 16. Emission Factors for Aircraft Estimates
by Landing to Take-Off Cycles

EMISSION FACTOR = LB. PER LTO CYCLE			
TYPE	SO2	NOx	VOC
AIR TAXI	0.015	0.158	1.223
COMMERCIAL	*** See FAEED (EDMS) MODEL ***		
GENERAL AVIATION	0.010	0.065	0.382
MILITARY	0.015	0.158	1.363

5.4. RAILROAD LOCOMOTIVES

Railroad locomotives are primarily of two types: electric and diesel-electric powered. Electric locomotives are powered by electricity generated at stationary power plants, which are generally part of the point source inventory. Diesel-electric locomotives use a diesel engine and generator to produce the required electrical power. Recent EPA guidance (Section 7.0, Ref. 14) was used in the development of this segment of the mobile source inventory. Currently there are no electric powered locomotives operating in Maine.

5.4.1. ESTIMATION METHODS

Total Statewide Fuel Use x % RR's in County = County Fuel Use
County Fuel Use x Emission Factor = Emissions

Emissions from this source category were based principally upon diesel fuel-use obtained from the US Department of Energy Information Administration *Fuel Oil and Kerosene Sales* document (Section 7.0, Ref. 13). Given total fuel-use by railroads in the state, statewide fuel-use was apportioned to the counties using the percentage of active track in each county (obtained from Maine DOT). The US EPA Office of Mobile Technical Highlight *Emission Factors for Locomotives* supplied the emission factors for NOx, VOC and CO (Section 7.0, Ref. 14). Emissions were calculated based on formulas in Chapter 6 of *Volume IV* of this document, while assuming uniform year-round activity.

Sample Calculations

$$C_F = S_F \times RR_{\%}$$
$$E_T = C_F \times EF$$

Where:

S_F = Statewide fuel usage from rail activity
C_F = Countywide fuel usage from rail activity
$RR_{\%}$ = Percentage of total rail mileage in county Y
E_T = Emission total for pollutant Y
EF = Emission factor for pollutant Y

Example: VOC Cumberland County

C_F = 1,846,000 gal. x 5.8%
= 108,733 gal.

E_T = 108,733 gal. x 0.02 lb. /gal.
= 1.2 Tons x 0.25 /91 Days
= 0.003 Tpswd

Table 17. Locomotives
Statewide Emission Factors in lbs. /gal.

Source Category	VOC	NOX	CO
Locomotives	0.02	0.60	0.06

5.5. VESSELS

Marine activity is classified in two ways, recreational and commercial vessels. Recreational boating generally includes vessels less than 100 ft. in length with the majority being less than 30 ft. These watercraft are powered by inboard or outboard engines and by either gasoline or diesel fuels.

Commercial (marine) vessels include boats and ships involved in commercial and military activity and vary from 20 ft. to over 1,000 ft. in length. The majority of commercial vessels are increasingly using diesel fuel here in the U.S. High-speed commercial and military watercrafts such as hydrofoils typically use gasoline. Commercial vessels use both distillate and residual fuel oil (usually #6 fuel oil) in diesel engines; however, some use a blend of both fuel types. Smaller diesel powered craft use distillate oil when maneuvering in port.

Emission estimates from vessels were developed using an activity factor, which involved the quantity and type of fuel in conjunction with an appropriate emission factor. This method was applied to estimated emissions produced by fuel burned in a vessel (boiler or engine) in port or at dockside (for heat, lights, refrigeration and ventilation, etc.)

5.5.1. ESTIMATION METHODS

A) Recreational Boating

Previously, Maine DEP calculated this category separately. These emissions are now included in the NONROAD model emissions.

B) Commercial Vessels

Marine activity is classified in two ways: recreational or commercial (including military). Recreational boating generally includes vessels less than 100 ft. in length with the majority being less than 30 ft. These are powered by both inboard and outboard engines and may be fueled by either gasoline or diesel. Emissions from recreational watercraft are currently a part of the EPA draft non-road model; and, therefore, were accounted for in the "Non-Road Mobile" Section 5.2, of the 1999 PEI.

Commercial marine activity includes both steam (residual) and diesel powered vessels. Estimates for both categories were calculated based on the fuel-sales methodology described *in EIIP, Volume IV - Mobile Sources* (Section 7.0, Ref. 9.d). Data on vessel-draft was obtained from the US Army Corps of Engineers, *1999 Waterborne Commerce of the United States, Part I: Atlantic Coast* (Section 7.0, Ref. 15) and statewide marine fuel usage data came from the US Department of Energy, *Fuel Oil & Kerosene Sales, 1999* (Section 7.0, Ref. 13).

The following calculations were used to apportion statewide fuel-sales to the county/port level.

$$A_R = V^1 / V^2$$
$$A_D = V^3 + (2 \times V^1) / (V^4 + 2 \times V^2)$$
$$Q_R = 0.25 \times A_R \times S_R$$
$$Q_D = 0.75 \times A_D \times S_D$$
$$E_{Tot} = (Q_R \times EF_S) + (Q_D \times EF_M)$$

Where:

V^1 = Vessels in port with draft > (greater than) or = (equal to) 18 ft.
V^2 = Vessels using all ports within state with draft > or = to 18 ft.
V^3 = Vessels in port with draft < (less than) 18 ft.
V^4 = Vessels using all ports within state with draft < 18 ft.

A_R = Apportioning factor for residual fuel sold in port
A_D = Apportioning factor for distillate fuel sold in port

S_R = Total quantity of residual oil sold in State for marine use
S_D = Total quantity of distillate oil sold in State for marine use

Q_R = Total quantity of residual oil used in port
Q_D = Total quantity of distillate oil used in port

E_T = Emission total for pollutant Y
EF_S = Steamship (residual) emission factor for pollutant Y
EF_M = Motor-ship (distillate) emission factor for pollutant Y

Example: VOC Cumberland County

$$A_R = 17979 / 19307 = 0.93$$
$$A_D = 2 + (2 \times 17979) / (16657 + 2 \times 19307) = 0.65$$
$$Q_R = 0.25 \times 0.93 \times 5{,}098{,}000\text{gal.} = 1{,}185{,}000\text{gal}$$
$$Q_D = 0.75 \times 0.65 \times 6{,}816{,}000\text{gal.} = 3{,}323{,}000\text{gal}$$
$$E_T = [(1185 \times 0.7) + (3323 \times 50)] / 2000 = 83.7 \text{ Tons} \times 0.25 / 91\text{days}$$
$$= 0.23 \text{ Tpswd}$$

Table 18. Commercial Vessels
Emission Factors in lbs./1000 gal.

Source	VOC	NOX	CO
Steamships*	0.7	55.8	3.5
Motorships**	50	32	110

*Residual Oil **Distillate Oil

6.0. BIOGENIC SOURCES

The Air Bureau has used the PC-BEIS biogenic emission estimates provided by US EPA, Office of Air and Quality Planning and Standards (OAQPS, Section 7.0 Ref. 35).

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